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TEST PLANNING, COLLECTION AND ANALYSIS OF PRESSURE DATA RESULTS--ETC(U)

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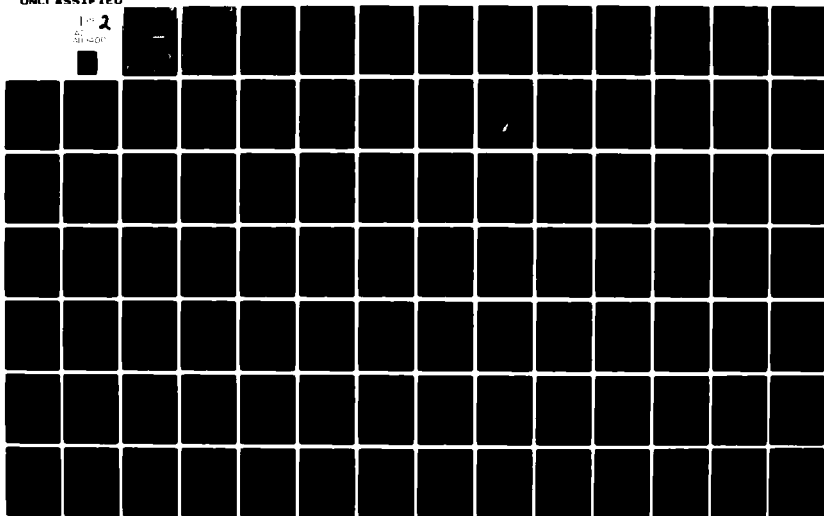
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TEST PLANNING, COLLECTION AND ANALYSIS  
OF PRESSURE DATA RESULTING FROM ARMY  
WEAPON SYSTEMS. VOL V - SHOCK TUBE  
ANALYSIS AND CORRELATION STUDY

Final Report

Steve Slinker  
Henry C. Evans  
Carol Jordon

May 1980

Supported by  
US Army Medical Research and Development Command  
Fort Detrick  
Frederick, MD 21701

Contract No. DAMD17-78-C-8087

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A118400	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) TEST PLANNING, COLLECTION, AND ANALYSIS OF PRESSURE DATA RESULTING FROM ARMY WEAPON SYSTEMS - VOL V - LOVELACE DATA ANALYSIS AND CORRELATION STUDY		5. TYPE OF REPORT & PERIOD COVERED FINAL REPORT - VOLUME V 1979 - May 1980
7. AUTHOR(s) Steve Slinker Henry C. Evans Carol Jordon		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS JAYCOR 1401 Camino Del Mar Del Mar, CA 92014		8. CONTRACT OR GRANT NUMBER(s) DAMD17-78-C-8087
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Medical Research and Development Center Fort Detrick Frederick, MD 21701		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 61102A.3M161102BS01.00.064
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE May 1980
		13. NUMBER OF PAGES 102
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for Public Release; Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Correlation Coefficients M198 howitzer Charge M203 Propellant Charge Variation of Waveforms M109 howitzer Blast Overpressures Peak Pressures Shock Tube		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This research project compares the blast overpressures from the Shock Tube of Lovelace Inhalation and Toxicology Research Institute to ascertain its conformity to the blast from the M198 howitzer fired with the M203 propellant charge. The Shock Tube is used for differing rates of fire and to approximate the gunner's position on the howitzer. With a slower rate of fire and with reflecting plates in the shock tube a closer correlation is achieved.		

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## SUMMARY

This report compares the blast overpressure from the shock tube under supervision of the Lovelace Inhalation and Toxicology Research Institute. The comparison of data is with the far field data obtained from trial firings from the M198 howitzer using the M203 charge. The purpose of this research is to ascertain if there is a reasonable correlation and possible duplication of pressure shocks from a shock tube so that future research can use data generated by a shock tube. Test firings of howitzers are costly in terms of timing, personnel, weather and funds. By using a shock tube Walter Reed Army Institute of Research could attain blast information against various animals under controlled conditions. It is concluded that with an addition of a reflector plate in the shock tube there is a close correlation of shock data to the field trial firings of the howitzer.

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## SECTION 1 INTRODUCTION

### 1-1 BACKGROUND

Recent improvements in the propellant charges used in howitzers have caused concern that the acoustic shock wave produced in crew areas may be strong enough to cause respiratory damage. In an attempt to study this possible hazard Walter Reed Army Institute of Research (WRAIR) has asked the Lovelace Inhalation and Toxicology (I&T) Research Institute to simulate with a shock tube the blast wave produced by a howitzer. Specifically, the blast wave produced by the M198 howitzer with the M203 propellant charge at the gunner's position, 4 feet off the ground is to be simulated. This position is designated the C22 position on the howitzer (see Figure 1-1). The howitzer is fired at 0 mils azimuth (center of traverse) and 267 mils quadrant elevation. A pressure time history recorded at this position from tests made at Aberdeen Proving Grounds in November 1978 is shown in Figure 1-2.

From March 22 to April 2, 1979, test firings of the shock tube were made by personnel at the Lovelace I&T Research Institute. The data recorded was analyzed by JAYCOR and is reported in Reference 1.

Further test firings were made from May 22 to June 4, 1979. The purpose of these tests was to improve the reproducibility of the blast wave generated by the shock tube.

### 1-2 REPORT STRUCTURE

This report is an analysis of the data taken during this shock tube test series. A brief description of the test design and the major conclusions drawn from the data analysis follow in this chapter. Section 2 of this report contains descriptions of the data collection and processing. The summary data from this test and previous tests of shock tube and howitzer are the basis for conclusions drawn and are also presented in Sections 2 and 4. Section 3 contains detailed data for each of the shots in the test and Section 5 contains graphs of some of the shots used in the analysis.

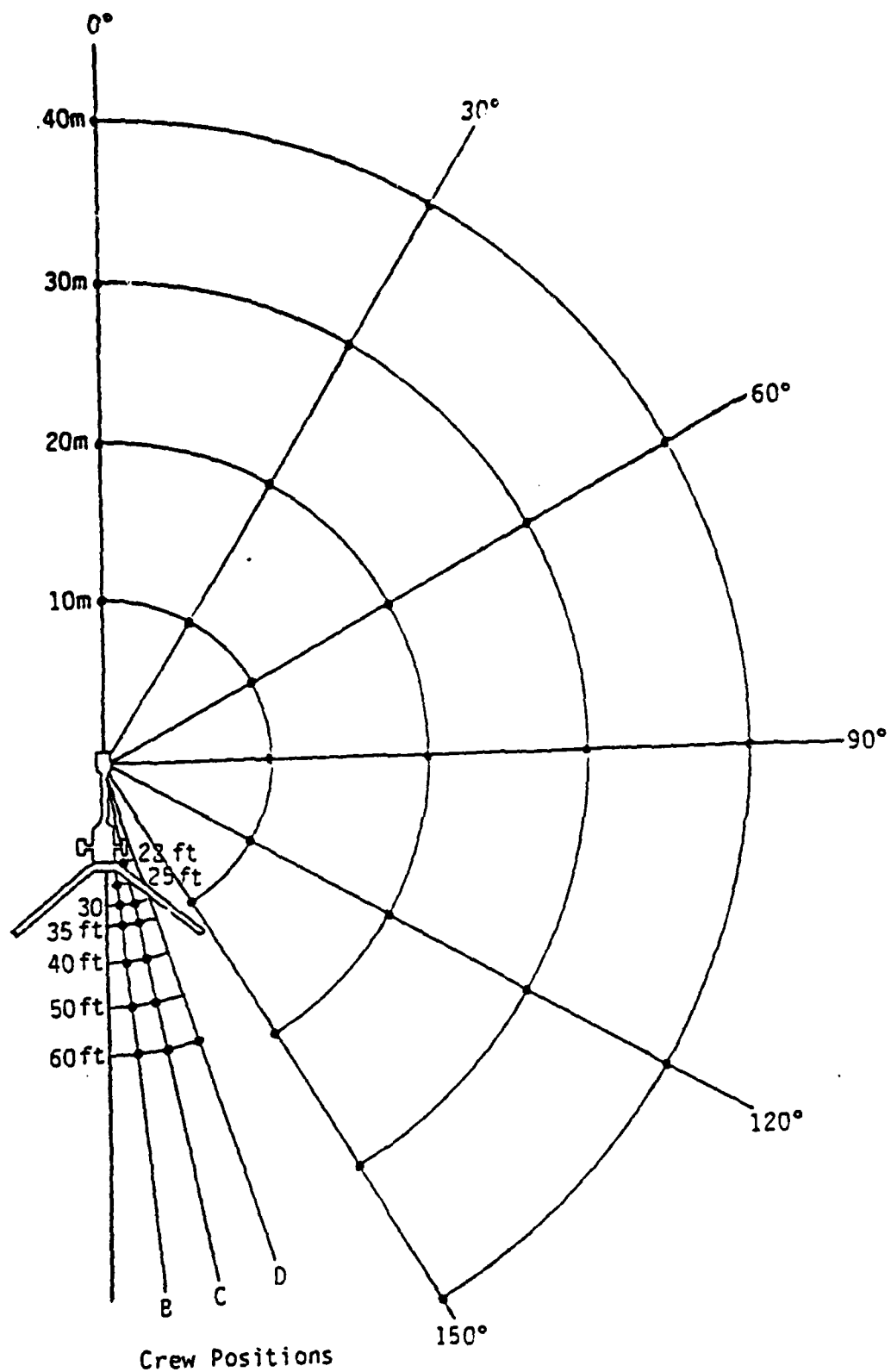


Figure 1-1 Ground map for locations of measurement.

### 1-3 TEST DESIGN

A dominant characteristic of the blast produced at the C22 position of the howitzer is the presence of a pressure peak due to the reflection of the shock wave off the ground (see Figure 1-2). In the March 1979 tests of the shock tube, the simulated reflected peak was produced by a second coil of primercord located an appropriate distance from the main coil within the shock tube. These primercord coils were electrically ignited simultaneously to produce the blast wave. In the May tests, the second coil was replaced by a reflecting plate. Consequently only one explosion occurs. It was anticipated that any timing problems with ignition of the primercord would be eliminated and the resulting blast waves would be more uniform.

A second major purpose of the May tests was to investigate the repetition of the firing rate which could reliably be achieved with the shock tube. Since the howitzer can be fired at rates up to three shots per minute, it was desired that the shock tube also be fired at this maximum rate. Though this is physically possible to achieve, it appeared that the variance from shot to shot was unacceptable. This is probably due to a need for the tube to "cool" down and for the hot gases produced by the shock tube to disperse. In the May 1979 series, repetition rates of three per minute were tested.

After some preliminary investigations to determine the appropriate primercord and reflector plate configuration, the testing began on May 22, 1979 and terminated June 4, 1979. Table 1-1 summarizes the test sequence. The entire test consisted of eight sets of 25 shots each and in each set the time between shots was constant. For each shot a 40 foot length coil of 100 gram primercord was used. It was located nine feet from the reflector plate in the shock tube.

Data was collected by four ST-2 pressure transducers located at two locations; one, directly on the axis of the shock tube approximately six feet from the opening, the other was two feet from the first, perpendicular to the axis. Two gauges were put at each position: one oriented face-on to the blast wave and one grazing. The purpose of the face-on gauges was to obtain an indication of the dynamic pressures.

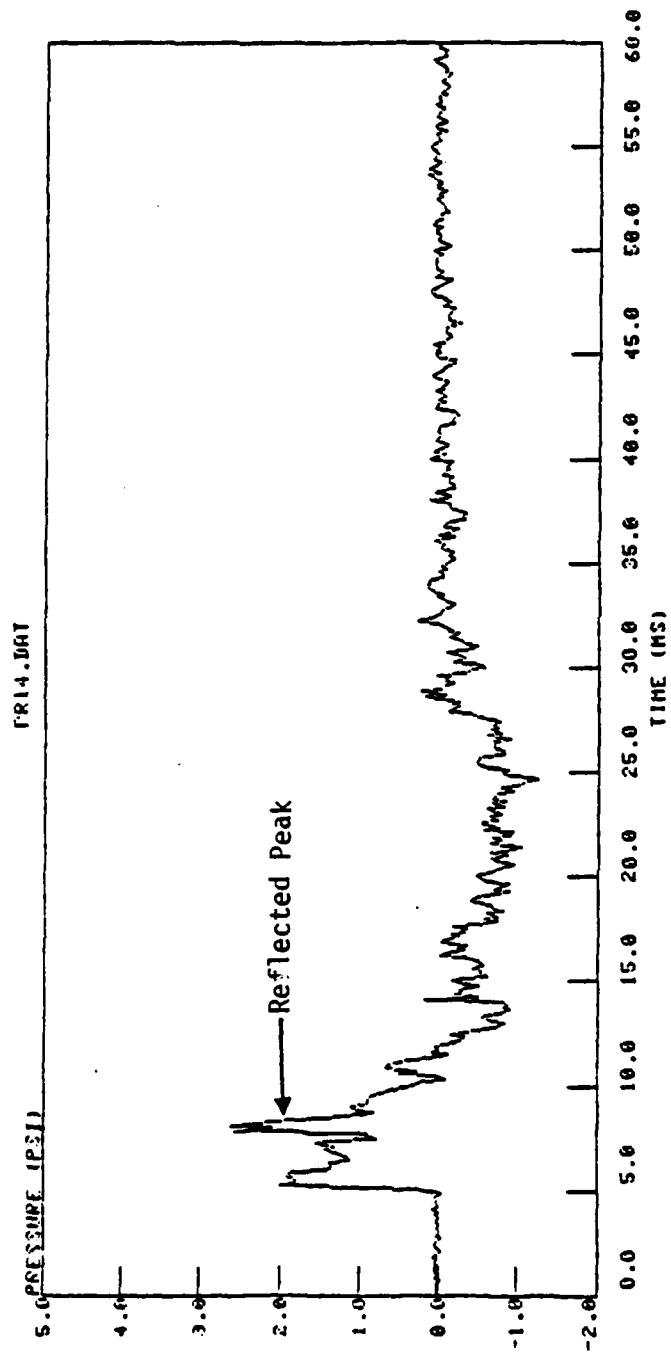


Figure 1-2. Pressure Time History, C22 Position, 4 ft Above Ground, M198, Nov 78

TABLE 1-1. SUMMARY OF TEST

<u>Name Used in Report</u>	<u>Day of Test (1979)</u>	<u>Time Between Shots</u>	<u>Average Temperature (°C)</u>	<u>Average Barometric Pressure (mm Hg)</u>
Day 1	22 May	3 min	24.8 - 30.0	625.0 - 624.6
Day 2	23 May	3 min	26.2 - 28.0	626.9 - 626.3
Day 3	24 May	1 min	18.4 - 20.8	626.6 - 626.5
Day 4	25 May	20 secs	18.2	625.3
Day 5	30 May	1 min	20.4 - 21.6	622.6 - 622.6
Day 6	30 May	30 secs	25.2	621.9
Day 7	1 June	30 secs	16.2 - 16.3	626.3 - 626.6
Day 8	4 June	1 min	21.5 - 22.2	623.0 - 623.0

Though the gauges were switched during the testing the following convention for the gauges was:

GAUGE 1: LOCATED ON AXIS, ORIENTED FACE-ON  
GAUGE 2: LOCATED ON AXIS, ORIENTED GRAZING  
GAUGE 3: LOCATED ON AXIS, ORIENTED FACE-ON  
GAUGE 4: LOCATED ON AXIS, ORIENTED GRAZING

#### 1-4 CONCLUSIONS

The major conclusions drawn from this test are listed below. The data which support these conclusions are found in the ensuing sections of this report.

- o Addition of the reflector plate improved the shot-to-shot reproducibility of the shock tube.

- o The modification of the shock tube, however, introduced a small pressure pulse about 180ms from the shock front. The effects of this pulse must be considered in the implementation of any future experimentation especially when exposing animals or humans to the shock tube blasts.

- o The shot-to-shot reproducibility of the shock tube improves as the time between shots increases. A rate of three shots per minute is probably too fast to give acceptable shot-to-shot uniformity for physiological experiments. Performance is much better at a rate of one firing per minute while two per minute may be acceptable in some cases.

- o On a given day, the shot-to-shot correlations of the shock tube are comparable to that of the howitzer.

- o There is a day-to-day variability in the shock tube. However, this is also true for the howitzer.



## SECTION 2 DATA COLLECTION AND PROCESSING

### 2-1 DATA COLLECTION AND DIGITIZATION

The data from the four ST-2 transducers were collected and recorded at the Lovelace Inhalation and Toxicology Research Institute. A dubbing of the analog tapes was performed by personnel at the US Army Aeromedical Laboratory (USAARL) at Ft. Rucker, Alabama. The dubbed tapes were then sent to JAYCOR for digitization and processing.

A preliminary study was made to determine the best sampling rate. Three shots were sampled with different combinations of sampling rate and tape playback speed. The results are summarized in Table 2-1.

As was expected, the peak pressures increased with sampling rate (the greater the sampling rate, the greater the chance of sampling near the peak analog signal), and the standard deviation between trials on the same shot decreased with sampling rate.

It was decided to use a sampling rate of 160 KHz with no analog antialiasing filter. Due to the high levels of pressure encountered in the face-on gauges from the gauge surface reflected pulse (see Ref 1), and due to the diffraction spike or overshoot, it was decided to omit the filter which would tend to flatten these high frequency spikes. As explained in Section 3-1, an attempt was made to correct for the overshoot. The resulting parameter is called the Estimated Peak Pressure and is used in this report.

During the samplings, record lengths of 206.25ms were taken which corresponds to 33,000 digitized points.

TABLE 2-1. DETERMINATION OF SAMPLING RATE

<u>Effective Sampling (Hz)</u>	<u>SHOT A Average Peak Over-pressure</u>	<u>Standard Deviation</u>	<u>SHOT B Average Peak Over-pressure</u>	<u>Standard Deviation</u>	<u>SHOT C Average Peak Over-pressure</u>	<u>Standard Deviation</u>	<u>Number of Samplings at this rate</u>
10 K	3.97	0.06	4.84	0.10	3.82	0.13	2
20 K	4.56	0.65	4.35	0.58	3.97	0.34	4
40 K	4.78	0.38	4.31	0.33	4.24	0.36	6
80 K	5.01	0.14	4.83	0.10	4.48	0.15	6
160 K	5.21	0.04	4.84	0.02	4.64	0.05	4
320 K	5.27	0.07	4.88	0.01	4.82	0.04	2

TABLE 2-2. CONVERSION FACTORS

	<u>Gauge 1</u>	<u>Gauge 2</u>	<u>Gauge 3</u>	<u>Gauge 4</u>
Day 1	1.153	1.124	1.105	1.138
Day 2	1.152	1.138	1.102	1.139
Day 3	1.101	1.029	1.167	1.138
Day 4	1.115	1.126	1.167	1.133
Day 5-6	1.126	1.142	1.179	1.145
Day 7	1.124	1.130	1.147	1.130
Day 8	1.139	1.123	1.155	1.135

TABLE 2-3. % CHANGE IN CALIBRATION FACTORS  
(SINUSOIDAL CALIBRATION)

	<u>Gauge 1</u>	<u>Gauge 2</u>	<u>Gauge 3</u>	<u>Gauge 4</u>
Day 1	xxx	xxx	-1.1%	xxx
Day 2	0.1%	0.6%	10.6%	1.9%
Day 3	1.5%	2.2%	-6.5%	0.2%
Day 4	1.0%	2.9%	-0.5%	0.9%
Day 5-6	2.2%	0.5%	0.3%	-3.1%
Day 7	xxx	1.7%	-2.6%	1.0%
Day 8	2.2%	3.8%	-0.9%	0.3%

## 2-2 CALIBRATION DATA

Each gauge was calibrated by Lovelace before and after each series of test firings. Two different calibration methods were used: a pulse calibration signal, and a sinusoidal calibration signal. For a discussion of these two types of calibrations, see Ref. 1.

All results presented in this report were derived using the sinusoidal calibration data. Table 2-2 gives the conversion factors needed to convert from sinusoidal to pulse calibration. Any quantity having units of PSI can be converted to the pulse calibration by multiplying by the appropriate value from the table. All time measurements will remain the same.

Table 2-3 gives the percent of change from pre-shot to post-shot calibration factors using the sinusoidal calibration signals. The numbers give an indication of instrumentation drift during the particular test series.

## 2-3 DATA ANALYSIS

There were four shots for which no data was recorded. These were shot 8 on Day 2, shots 11 and 23 on Day 6 and shot 11 on Day 7.

Electronic problems were exhibited in the data for several shots. In particular, the signals recorded on Gauge 3 for shots 4-25 on Day 6 were unusable. Electronic problems occurred most frequently on the first day of the test, May 22. The data collected from Gauge 2 was unreadable and the signal quality from the other three gauges decreased as this day's series progressed. Figures 2-1 and 2-2 illustrate this decrease in quality. Figure 2-1 is the pre-shot calibration signal recorded by Gauge 3, while Figure 2-2 is the post-shot calibration signal recorded by the same gauge. Figure 2-3 shows the noise and ringing present in the Gauge 3 records for this day. Similar noise was found on the other gauge's records for day 1. Consequently, although data were reported for Gauges 1,3 and 4 on Day 1, the quality of the signals was not nearly as clear as on the other days and the data from Day 1 should be used with caution.

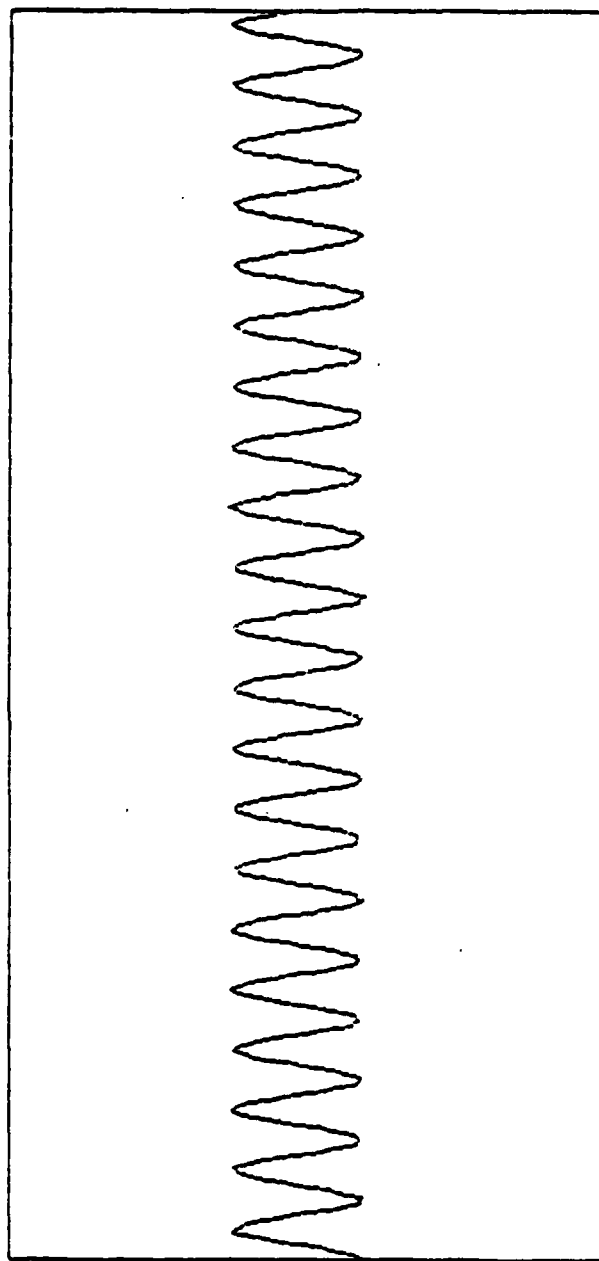


Figure 2-1. Preshot Calibration Signal, Gauge 3, Day 4

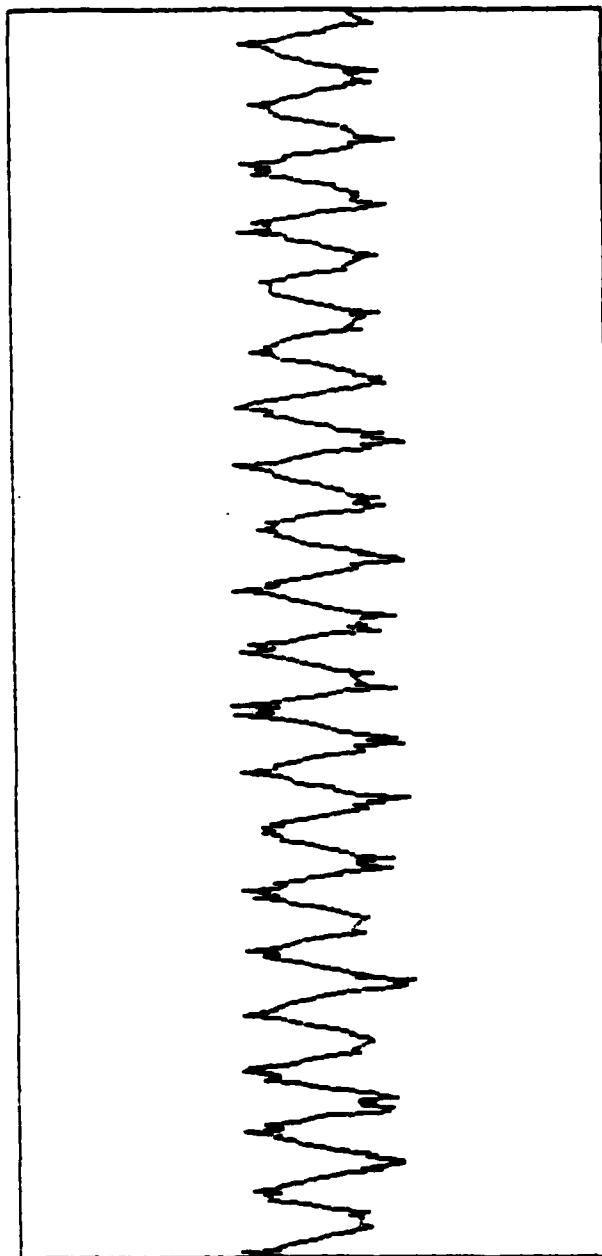


Figure 2-2. Postshot Calibration Signal, Gauge 3, Day 1

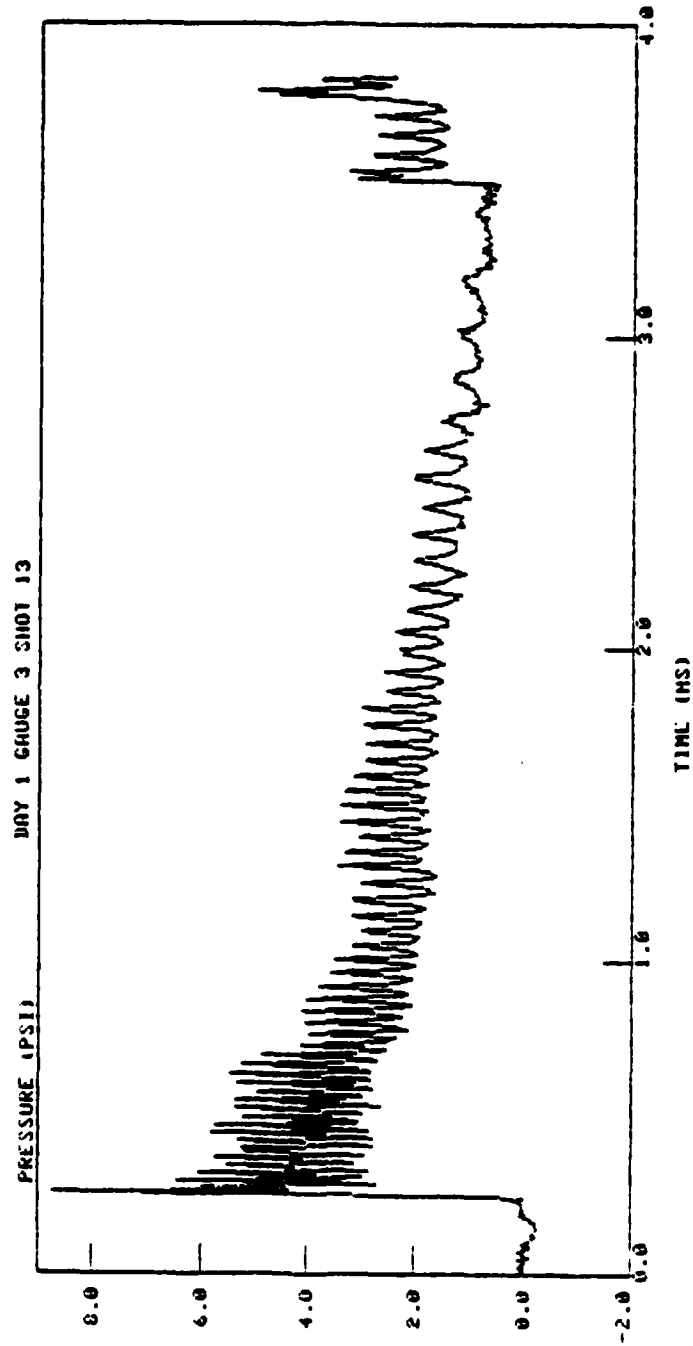


Figure 2-3. Example of Day 1 Record Exhibiting Ringing

Figures 2-4 and 2-5 are typical pressure time histories. Figure 2-4 was taken from a face-on gauge on Day 3. Figure 2-5 was taken from a grazing gauge. About two hundred milliseconds of the records are shown.

Note the pulse which occurred about 180ms from the main peak. This pulse was not present in the records from the March 1979 shock tube tests and, therefore, was probably due to the presence of the reflector plate. Though these pulses were much smaller than the main shock fronts, they nevertheless had peak pressures over 1 PSI and their effects should not be neglected in any experiments. The pulse was not present in the first 200-225ms after the main pulse in the previous test. Longer record lengths were not available to the investigator.

Figures 2-6 and 2-7 are expanded forms of the same shots as shown in Figures 2-4 and 2-5. Of particular note is the extremely sharp spike of short duration which occurred at the shock front. Several phenomena contributed to its existence. For the face-on gauges (Gauges 1 and 3), a major contribution to the spike was the reflection of the shock front off the face of the gauge. Theory predicts that the pressure at the point of reflection of an acoustic shock wave normal to a planar surface is over twice as great as the pressure in the shock front in free space. Though the surface of the gauge is small, it is still finite in extent and the contribution of the reflected shock front was present.

Other factors which contributed to the presence of the spike were edge effects of the gauge, gauge overshoot, and misalignment of the grazing gauges (i.e., if the surface was not perfectly grazing to the shock front, then the reflection off the gauge surface would have an effect).

Since these spikes had a high frequency content, one method of handling them was to send the signals through a low pass antialiasing filter before digitization. However, since a major part of the spike was not due to an artifact, it was decided not to use the filter and, instead, to make an attempt to eliminate the high frequency content influence through the processing procedure.

Lines were fitted to the time history in the region immediately following the spike. The line was then traced back in time to give an Estimated Peak Pressure

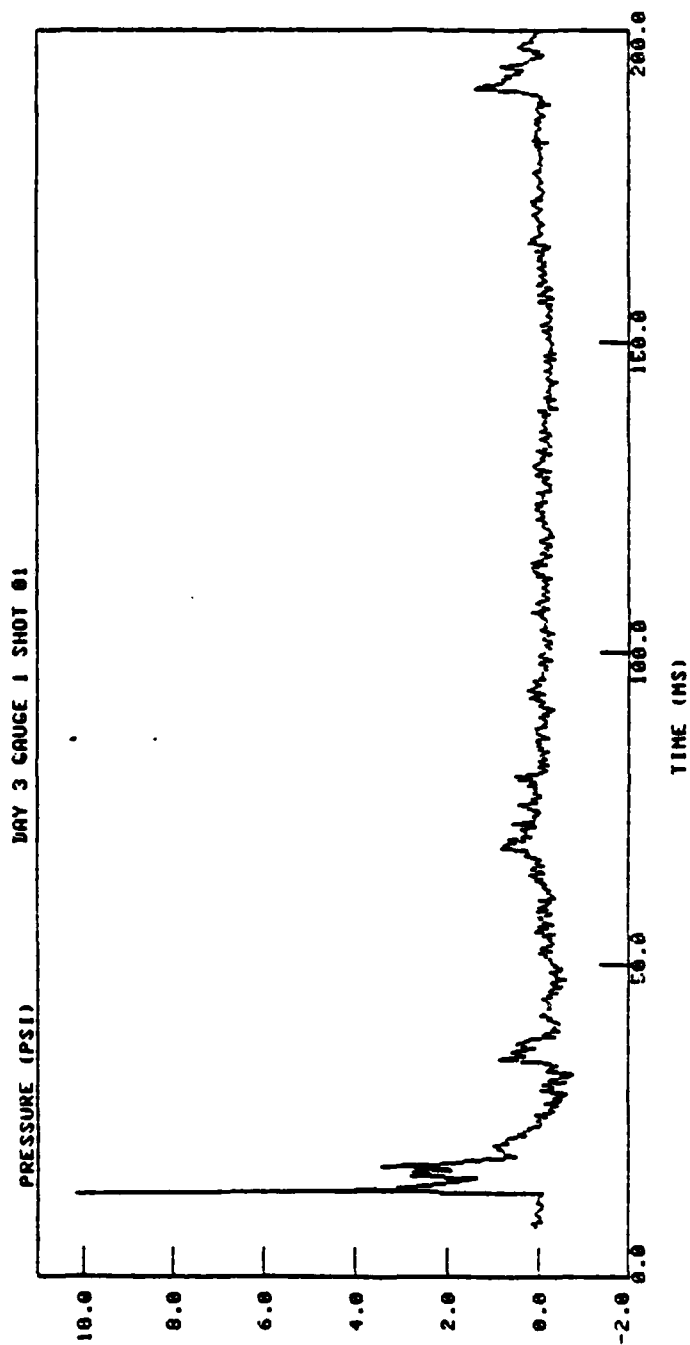


Figure 2-4. Pressure Time History, Face-On, Day 3



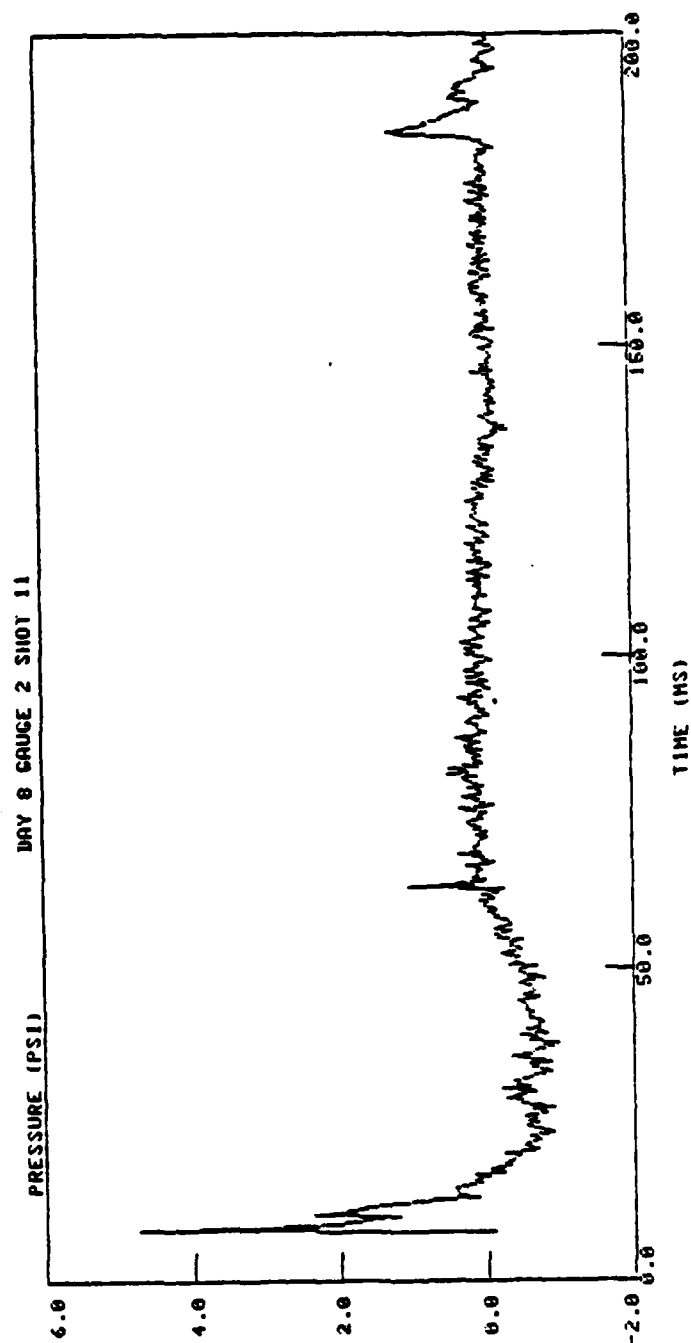


Figure 2-5. Pressure Time History, Grazing Gauge, Day 8

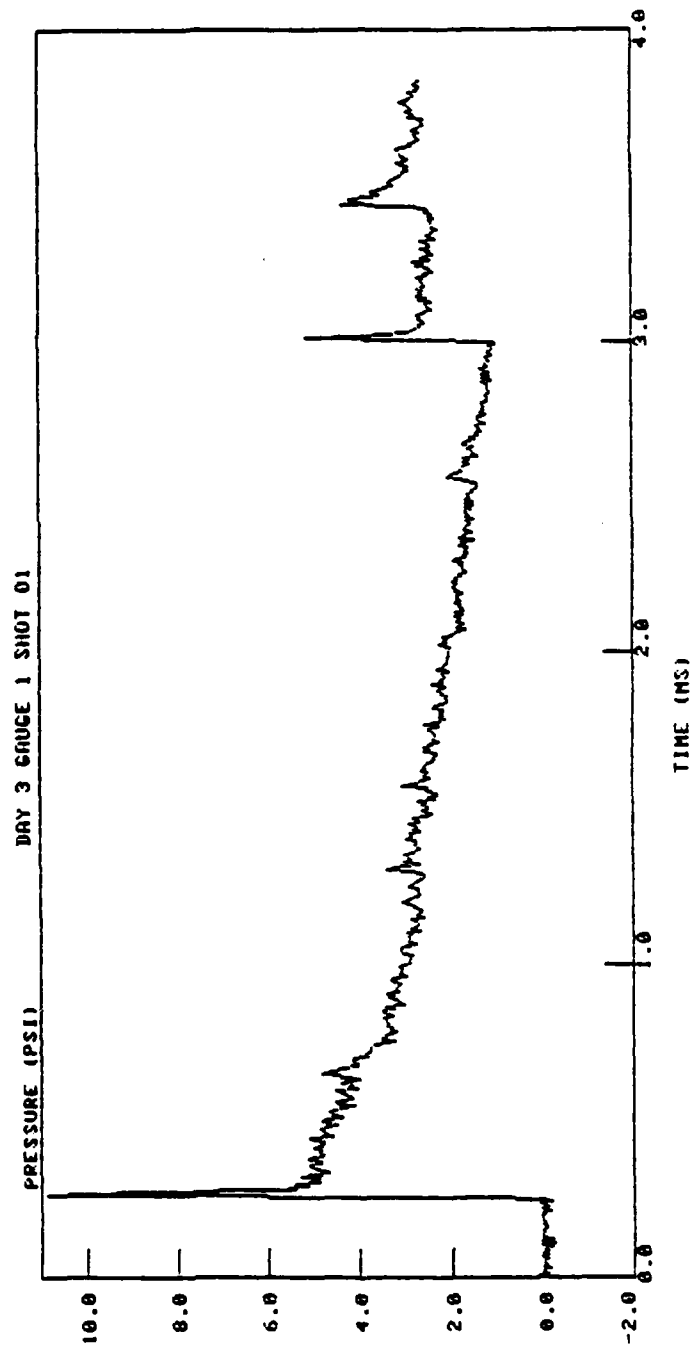


Figure 2-6. Face-On, First 4 ms

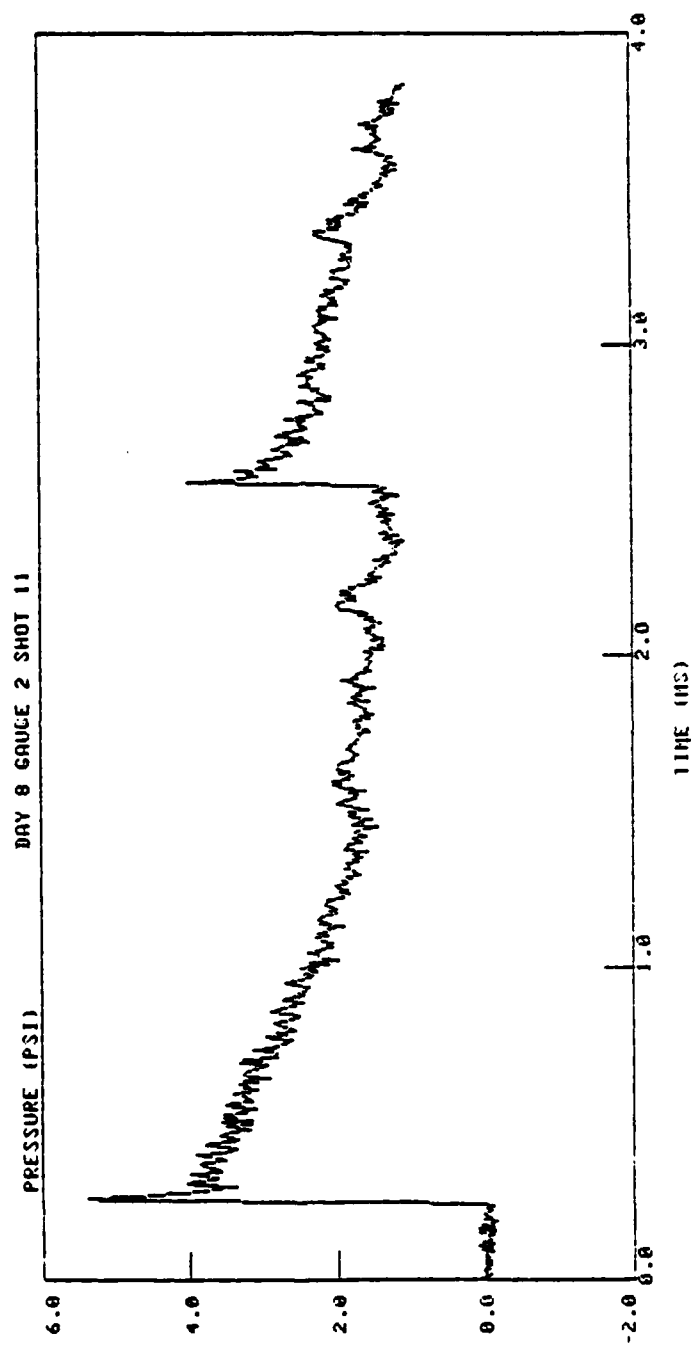


Figure 2-7. Grazing, First 4 ms

(see Figures 2-6 and 2-7). Section 4 contains tables of the actual recorded peaks and the estimated peaks.

Since the B-duration, MIL STD. 1474B, is defined in terms of the peak pressure, its value for a given pressure time history will depend on whether the actual record peak or the estimated peak is used. In the detailed data summaries in Section 3, both values of the B-duration are provided.

SECTION 3  
DETAILED DATA SUMMARY

3-1 TABLES OF DATA

This section contains tables of detailed data summaries for each of the shots during this test series. The parameters of the tables are:

SHOT	- Shot number.
MAXIMUM PRESSURE	- Maximum recorded pressure in both PSI and dB.
MIN	- Minimum recorded pressure in PSI (relative to ambient).
TIME MIN	- Time relative to the initial shock front at which the minimum recorded pressure occurred in milliseconds.
INIT MAX	- Maximum recorded pressure occurring during the initial pulse in PSI.
REFL MAX	- Maximum recorded pressure occurring in the pulse reflected from the reflector plate in PSI.
TIME REFL	- Time relative to the initial shock front at which the reflected maximum occurred in milliseconds.
EST MAX, AVE EST	- As described in Section 2, an attempt was made during processing to correct for the sharp spike occurring at the shock front. This was accomplished by fitting several lines to the curve. The maximum estimation is given as EST MAX and the average given by the fitting lines is AVE EST. Both are expressed in PSI.
A-DUR	- A-duration given in milliseconds.
B-DUR EST B-DUR	- The B-duration is in milliseconds. B-DUR uses the recorded maximum to calculate the B-duration. EST B-DUR uses the estimated maximum to determine the B-duration.
TOT IMP	- The total impulse of the record in PSI-Ms.
POS IMP	- The positive impulse from pulse onset until the A-duration in PSI-Ms.

TABLE 3-1. MAY 22, ON AXIS, FACE-ON, 3 MIN.

## LOVELACE SHOCK TUBE TEST

22 MAY 79

ON AXIS, FACE-ON

3 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		INIT	REFL	TIME		EST	AVE	ADUR		HOUR	MS	EST	TOT		POS
	PSI	DB	PSI	MS	PSI	MAX	MAX	MS	PSI	MAX	EST	MS	PSI	MS	MS	HOUR	IMP	MS	IMP
1	11.6	192.0	-0.9	34.11	11.6	5.4	5.4	3.14	4.9	4.8	4.8	9.7	4.8	27.	193.	1.0	17.3	--PSI-MS--	
2	11.4	191.9	-1.1	17.49	11.4	5.2	5.2	3.58	4.9	4.7	4.7	9.7	4.7	24.	199.	-2.5	17.0		
3	11.9	192.3	-1.2	32.35	11.9	6.0	6.0	3.83	5.3	5.1	5.1	9.7	5.1	27.	188.	0.5	17.5		
4	10.2	191.0	-1.0	32.39	10.2	8.1	8.1	4.32	4.9	4.7	4.7	9.7	4.7	55.	187.	-5.6	16.1		
5	12.1	192.4	-1.2	14.79	12.1	5.7	5.7	3.78	5.1	4.9	4.9	9.2	4.9	13.	189.	-0.1	17.3		
6	10.9	191.5	-1.3	31.76	10.9	7.7	7.7	3.86	5.3	5.2	5.2	9.2	5.2	58.	193.	-3.9	17.5		
7	10.8	191.4	-1.0	33.73	10.6	6.5	6.5	4.40	5.1	4.9	4.9	9.7	4.9	27.	183.	3.8	17.0		
8	11.8	192.2	-1.3	33.36	11.8	6.3	6.3	4.03	5.1	4.9	4.9	9.2	4.9	56.	195.	-2.1	16.8		
9	14.7	194.1	-1.1	14.44	14.7	6.0	6.0	3.94	5.6	5.4	5.4	9.6	5.4	8.	187.	0.5	17.3		
10	10.5	191.2	-1.1	33.54	10.5	5.7	5.7	4.37	5.0	4.7	4.7	9.5	4.7	56.	194.	-0.8	17.1		
11	10.9	191.5	-1.2	14.84	10.9	6.4	6.4	3.74	5.0	4.8	4.8	9.3	4.8	59.	190.	-1.5	17.3		
12	10.9	191.5	-1.1	14.92	10.9	7.2	7.2	3.74	5.4	5.2	5.2	9.4	5.2	27.	188.	3.0	18.0		
13	13.4	193.3	-1.3	14.78	13.4	6.6	6.6	3.82	5.4	5.3	5.3	9.7	5.3	55.	187.	-1.6	17.9		
14	12.8	192.9	-1.0	33.52	12.8	4.9	4.9	4.42	4.8	4.7	4.7	9.4	4.7	23.	195.	-1.9	16.7		
15	11.2	191.7	-1.3	31.83	11.2	5.0	5.0	4.09	5.2	5.0	5.0	9.2	5.0	56.	189.	-2.7	16.7		
16	13.0	193.0	-1.3	33.40	13.0	6.2	6.2	4.05	5.0	4.8	4.8	9.5	4.8	21.	205.	-9.5	17.0		
17	10.7	191.3	-1.0	14.82	10.7	5.6	5.6	4.26	5.4	5.2	5.2	9.3	5.2	28.	186.	3.2	17.3		
18	12.1	192.4	-1.3	14.89	12.1	6.7	6.7	4.00	5.5	5.2	5.2	9.3	5.2	18.	196.	-0.2	17.5		
19	13.0	193.0	-1.1	33.44	13.0	5.6	5.6	4.27	5.1	5.0	5.0	9.4	5.0	24.	195.	2.1	17.0		
20	12.9	192.9	-1.2	14.67	12.9	8.2	8.2	3.71	5.6	5.4	5.4	9.6	5.4	9.	192.	1.5	18.3		
21	10.6	191.3	-1.3	32.94	10.6	5.7	5.7	3.74	5.0	4.8	4.8	9.1	4.8	57.	198.	1.9	17.3		
22	13.7	193.5	-1.3	32.03	13.7	5.1	5.1	3.98	5.4	5.1	5.1	9.5	5.1	9.	194.	2.8	17.0		
23	11.9	192.2	-1.2	31.73	11.9	6.4	6.4	2.44	5.2	5.1	5.1	9.5	5.1	21.	188.	-1.3	17.3		
24	14.5	194.0	-1.2	27.11	14.5	6.6	6.6	3.66	5.1	5.0	5.0	8.7	5.0	9.	198.	-0.1	17.1		
25	11.0	191.6	-1.1	31.77	11.0	7.0	7.0	1.93	5.6	5.4	5.4	8.4	5.4	58.	189.	0.9	17.4		

TABLE 3-2. MAY 22, ON AXIS, GRAZING, 3 MIN.

## LOVEFACE SHOCK TUBE TEST

22 MAY 79

ON AXIS, GRAZING

3 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN PSI	TIME INIT		REFL		EST		AVE		ADUR		BDUR		EST		ROT		PNS	
	PSI	DH	PSI	MS	MAX PSI	MAX PSI	MS	MAX PSI	MAX PSI	EST PSI	EST PSI	MS	MS	MS	MS	BDUR MS	BDUR MS	IMP	IMP	--PSI-MS--	IMP
1	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 3-3. MAY 22, OFF AXIS, FACE-ON. 3 MIN.

LOVELAKE SHOCK TUBE TEST

22 MAY 79

OFF AXIS, FACE-ON

3 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		REFL.	EST MAX	AVE	ADUR	HOUR	EST HOUR	TOT POS	
	PSI	OH	PSI	MS	PSI	MS	PSI	PSI	MS	MS	MS	INP	IMP
1	11.2	191.7	-0.9	18.96	11.2	6.2	3.50	4.7	9.6	24.	182.	---	PSI-4S---
2	9.6	190.4	-0.9	17.59	9.6	5.0	3.67	4.7	9.7	24.	189.	-0.3	13.0
3	10.6	191.2	-1.3	31.73	10.6	6.3	2.94	4.8	9.4	56.	187.	3.3	13.7
4	9.4	190.2	-1.1	14.62	9.4	5.4	3.80	4.6	3.6	24.	201.	2.2	12.5
5	9.9	190.7	-1.1	34.51	9.9	5.1	2.51	5.0	9.4	58.	205.	5.9	14.0
6	9.7	189.5	-1.1	31.67	8.7	5.1	4.31	5.0	9.4	55.	199.	1.5	13.8
7	9.3	190.1	-0.9	31.77	9.3	4.9	4.61	4.9	7.1	24.	180.	1.0	11.9
8	10.1	190.9	-0.9	25.52	10.1	5.3	2.84	5.1	9.7	9.	185.	1.5	13.6
9	10.4	191.1	-1.2	39.82	10.4	5.0	3.42	4.9	8.8	55.	188.	1.6	13.3
10	8.8	189.6	-0.9	32.70	8.8	5.0	3.54	4.6	8.7	55.	187.	3.3	13.2
11	10.2	191.0	-1.0	32.06	10.2	4.6	4.21	4.7	0.0	6.	195.	-2.3	2.8
12	8.8	189.6	-1.1	25.57	8.8	4.8	3.14	4.7	9.1	56.	193.	0.1	13.6
13	11.7	192.1	-1.2	12.68	11.7	5.7	2.74	5.2	9.4	23.	182.	0.8	13.8
14	9.7	190.5	-5.9	0.00	9.7	5.3	2.92	4.9	9.4	22.	188.	-0.5	13.0
15	10.8	191.4	-1.1	32.07	10.8	4.9	2.90	4.7	9.3	22.	188.	3.2	13.5
16	9.6	190.4	-1.1	25.24	9.6	5.2	3.23	4.9	9.2	54.	189.	-2.7	13.6
17	10.4	191.1	-1.8	0.00	10.4	5.3	3.34	5.0	9.5	10.	178.	1.2	13.5
18	11.5	192.0	-7.1	0.00	11.5	5.0	3.26	5.0	9.4	21.	186.	1.4	13.8
19	11.1	191.7	-1.7	0.00	11.1	6.1	3.41	4.9	9.4	24.	189.	1.1	13.4
20	11.8	192.2	-2.7	0.00	11.8	5.0	2.66	5.0	9.2	20.	189.	5.9	14.3
21	10.3	191.0	-0.9	32.24	10.3	5.7	4.31	4.8	9.4	22.	192.	4.0	13.6
22	10.5	191.1	-1.2	25.64	10.5	6.0	4.43	5.1	6.4	56.	193.	2.8	12.1
23	11.6	192.0	-1.2	14.74	11.6	7.3	2.53	5.1	9.4	17.	188.	0.7	13.7
24	11.1	191.7	-1.1	34.56	11.1	5.1	2.59	5.2	8.6	26.	187.	4.7	13.6
25	11.7	192.1	-1.1	28.66	11.7	6.8	1.99	5.1	8.6	9.	192.	4.1	14.0



TABLE 3-4. MAY 22, OFF AXIS, GRAZING, 3 MIN.

## LOVELACE SHOCK TUBE TEST

22 MAY 79

OFF AXIS, GRAZING

3 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN PSI	TIME		INIT		REFL.		TIME REFL MS	EST MAX PSI	AVE EST PSI	ADUR MS	HDUR MS	EST BDUR MS	TOT IMP	POS IMP
	PSI	UR		414 MS	PSI	MAX PSI	MAX PSI	PSI									
1	5.8	185.9	-1.1	32.26	5.4	2.7	3.58	3.7	3.6	8.1	53.	144.	-11.9	9.7			
2	5.1	184.9	-1.0	32.03	5.1	3.3	3.64	3.7	3.6	6.8	96.	150.	-11.3	9.2			
3	5.9	186.2	-1.1	31.84	5.4	2.8	3.23	3.8	3.8	6.6	75.	149.	-9.0	9.6			
4	5.3	185.2	-1.1	26.06	5.3	2.9	3.76	3.8	3.7	8.1	69.	149.	-9.3	9.5			
5	5.6	185.7	-1.2	32.17	5.6	3.0	3.10	3.8	3.7	5.8	58.	152.	-8.0	9.6			
6	6.6	187.1	-1.5	33.59	6.6	3.5	2.58	3.8	3.8	6.5	49.	154.	-14.9	9.4			
7	5.6	185.8	-1.0	26.96	5.6	2.5	3.76	3.8	3.7	7.9	49.	107.	-11.3	9.7			
8	5.1	184.8	-1.3	33.00	5.1	3.2	3.21	3.7	3.6	8.0	106.	152.	-13.4	9.8			
9	5.9	186.1	-1.1	35.11	5.9	3.0	3.36	3.8	3.7	7.6	74.	150.	-8.0	10.0			
10	5.7	185.9	-1.2	31.83	5.7	2.9	3.51	3.7	3.6	8.1	54.	149.	-7.6	9.9			
11	4.9	184.5	-1.2	32.16	4.9	3.5	3.06	3.8	3.7	5.8	84.	153.	-4.7	9.3			
12	6.1	186.5	-1.3	25.56	6.1	3.4	3.11	3.7	3.6	7.5	55.	155.	-14.1	9.8			
13	5.3	185.3	-1.2	30.99	5.3	3.0	2.76	4.0	3.8	7.3	60.	150.	-12.4	9.8			
14	5.4	185.4	-1.2	14.25	5.4	2.8	3.41	3.8	3.7	7.7	54.	99.	-11.8	9.6			
15	6.3	186.7	-1.3	27.61	6.3	2.8	3.28	3.6	3.5	6.1	53.	152.	-14.4	9.1			
16	6.6	187.1	-1.3	25.13	6.6	3.3	3.16	3.8	3.7	7.8	59.	151.	-12.9	10.0			
17	5.0	184.7	-1.1	15.18	5.0	3.3	3.11	3.8	3.7	6.6	70.	153.	-9.8	9.3			
18	6.1	186.5	-1.3	15.16	6.1	3.3	3.14	3.9	3.7	8.1	55.	154.	-12.9	9.9			
19	6.2	186.6	-1.1	32.76	6.2	3.0	3.38	3.8	3.6	6.4	48.	148.	-12.3	9.0			
20	6.4	186.8	-1.3	25.15	6.4	3.4	3.09	3.8	3.8	8.0	54.	148.	-10.5	10.1			
21	6.1	186.5	-1.2	24.91	6.1	3.0	3.16	3.8	3.7	6.6	54.	130.	-12.1	9.3			
22	6.1	186.4	-1.3	25.54	6.1	2.6	2.73	3.9	3.8	5.8	49.	150.	-11.0	9.0			
23	5.5	185.6	-1.2	15.11	5.5	3.5	2.56	4.0	3.8	7.4	40.	155.	-10.7	9.8			
24	6.6	187.1	-1.2	31.08	6.6	3.7	3.06	3.8	3.8	7.6	57.	154.	-12.7	10.0			
25	5.5	185.6	-1.4	24.55	5.5	4.0	2.03	3.9	3.8	7.2	84.	151.	-10.7	10.0			

TABLE 3-5. MAY 23, ON AXIS, FACE-ON, 3 MIN.

## LOVELACE SHOCK TUBE TEST

23 MAY 79

ON AXIS, FACE-ON

3 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		INIT	REFL	TIME	EST	AVE	ADUR	HDUR	EST	FOR IMP	IMP	PUS
	PSI	DB		MIN	MS											
1	10.8	191.4	-1.0	13.78	10.8	5.1	3.14	5.0	4.9	9.3	23.	135.	-0.9	16.6		
2	10.3	191.0	-0.8	12.28	10.3	6.0	4.10	5.2	5.0	9.3	23.	140.	-3.2	17.0		
3	10.9	191.5	-0.8	32.80	10.9	6.1	4.30	5.1	4.9	9.7	8.	85.	1.7	17.0		
4	11.3	191.8	-0.8	33.49	11.3	5.6	4.03	5.0	4.8	9.7	8.	140.	-1.1	16.6		
5	11.2	191.8	-0.9	33.93	11.2	4.9	3.84	5.1	5.0	9.6	10.	140.	-0.7	16.9		
6	11.1	191.7	-0.9	13.94	11.1	5.8	3.92	4.7	4.6	8.8	34.	144.	-0.3	16.0		
7	10.8	191.4	-0.9	19.14	10.8	5.1	3.17	4.9	4.8	9.0	59.	135.	-2.2	16.2		
8	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.	0.	0.0	0.0		
9	11.0	191.6	-0.8	33.88	11.0	6.3	3.96	5.0	4.9	9.6	23.	139.	-1.6	17.3		
10	10.8	191.4	-0.8	32.17	10.8	5.3	3.79	5.1	5.0	8.9	12.	145.	-1.0	16.9		
11	10.5	191.2	-0.8	33.51	10.5	6.7	3.63	5.1	5.0	9.5	10.	81.	-4.1	17.3		
12	10.5	191.2	-0.8	13.94	10.5	5.5	4.39	4.8	4.7	9.1	25.	81.	-1.7	16.3		
13	12.1	192.4	-0.8	20.91	12.1	5.6	3.96	5.0	4.9	9.6	8.	80.	-0.9	16.7		
14	11.8	192.2	-0.9	34.14	11.8	6.4	4.29	4.7	4.5	9.5	8.	140.	-2.7	17.3		
15	11.4	191.9	-0.8	11.59	11.4	7.1	1.65	5.0	4.9	8.3	27.	104.	-1.5	17.2		
16	11.0	191.5	-0.9	14.73	11.0	5.6	2.54	5.1	5.0	6.8	10.	136.	-0.1	15.8		
17	12.4	192.6	-1.0	13.74	12.4	6.3	2.37	5.2	5.2	9.5	24.	135.	-2.1	17.4		
18	11.1	191.6	-0.9	13.82	11.1	5.6	2.52	5.3	5.2	8.7	23.	85.	0.5	17.0		
19	11.9	192.3	-0.9	14.86	11.9	5.5	3.80	4.9	4.9	8.9	8.	81.	-2.9	16.9		
20	11.5	192.0	-0.8	30.86	11.5	5.7	4.40	5.1	5.0	9.6	23.	59.	-0.3	16.9		
21	11.7	192.1	-0.8	11.63	11.7	6.3	4.57	4.8	4.8	9.8	23.	140.	3.6	17.6		
22	11.7	192.1	-0.9	14.49	11.7	6.3	2.42	5.4	5.3	8.5	12.	101.	-0.9	17.5		
23	11.3	191.8	-0.9	33.47	11.3	5.1	4.21	5.0	5.0	9.0	24.	112.	-10.0	16.1		
24	11.5	192.0	-0.8	17.18	11.5	4.7	4.15	4.8	4.7	9.5	24.	94.	0.9	17.3		
25	12.5	192.7	-0.7	15.14	12.5	5.9	4.36	5.3	5.2	9.9	22.	72.	17.4	18.2		

TABLE 3-6. MAY 23, ON AXIS, GRAZING, 3 MIN.

## LOVELACE SHOCK TUBE TEST

23 MAY 79

ON AXIS, GRAZING

3 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN PSI	TIME		INIT MAX PSI	REFL MAX PSI	TIME REFL MS	EST MAX PSI	AVE EST PSI	ADUR MS	BDUR MS	EST BDUR MS	TOT IMP	POS IMP
	PSI	DB		MIN MS	MS										
1	5.2	185.0	-1.0	18.74	5.2	3.1	3.15	3.8	3.8	3.8	7.0	72.	135.	-5.0	10.3
2	5.4	185.4	-1.1	30.61	5.4	4.2	3.84	3.9	3.8	3.8	6.3	66.	136.	-6.0	10.7
3	5.2	185.1	-1.2	25.31	5.2	3.4	4.21	3.7	3.7	3.7	5.2	57.	127.	-2.8	9.1
4	5.3	185.3	-1.1	25.63	5.3	2.9	4.22	3.6	3.6	3.6	5.2	85.	148.	-5.5	9.0
5	5.2	185.1	-1.2	25.58	5.2	2.7	3.88	3.9	3.8	3.8	6.8	81.	114.	-4.3	10.3
6	4.8	184.3	-0.9	14.05	4.8	2.8	4.30	3.7	3.6	3.6	5.6	114.	144.	-1.1	10.1
7	5.3	185.2	-1.0	17.57	5.3	2.8	4.34	3.7	3.7	3.7	5.5	148.	148.	-0.8	9.7
8	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0
9	1.6	174.6	-0.3	21.53	1.6	0.2	15.56	0.0	0.0	0.0	0.0	155.	156.	-0.3	0.0
10	5.3	185.2	-1.3	25.61	5.3	2.8	3.49	3.9	3.8	3.8	5.1	64.	134.	-7.3	9.4
11	5.5	185.6	-1.1	25.38	5.5	3.3	3.54	3.9	3.8	3.8	5.4	106.	148.	-3.4	10.3
12	4.9	184.5	-1.0	39.09	4.9	3.5	4.32	3.7	3.6	3.6	8.4	128.	135.	-1.5	10.8
13	5.2	185.0	-1.0	35.31	5.2	3.0	3.88	3.8	3.8	3.8	5.3	114.	130.	-2.5	9.7
14	5.0	184.8	-1.0	18.07	5.0	3.2	4.19	3.7	3.5	3.5	5.1	109.	128.	-2.0	8.5
15	5.0	184.7	-1.2	22.02	5.0	3.7	1.68	3.9	3.8	3.8	5.3	85.	150.	-1.2	11.0
16	5.3	185.3	-1.1	14.08	5.3	3.0	1.82	4.0	3.9	3.9	5.3	73.	143.	-2.4	10.1
17	5.5	185.6	-1.3	25.13	5.5	3.0	1.56	3.9	3.9	3.9	5.4	81.	148.	-3.9	10.9
18	5.5	185.7	-1.2	13.85	5.6	2.9	2.53	4.1	4.0	4.0	6.7	87.	143.	-5.0	10.9
19	5.3	185.3	-1.1	18.41	5.3	3.1	3.74	3.9	3.8	3.8	5.3	107.	135.	-4.9	9.9
20	5.2	185.1	-1.2	18.04	5.2	3.0	4.31	3.9	3.8	3.8	8.5	114.	135.	1.0	11.1
21	5.3	185.3	-1.0	17.42	5.3	3.5	4.48	6.6	6.3	6.3	5.8	114.	88.	-0.7	9.7
22	5.5	185.6	-1.4	25.23	5.5	3.8	2.44	4.0	3.9	3.9	5.8	65.	134.	-3.8	10.6
23	5.5	185.6	-1.0	33.03	5.5	2.9	3.08	3.8	3.8	3.8	5.4	78.	133.	-3.0	9.8
24	5.1	184.8	-1.2	25.13	5.1	2.6	2.91	3.8	3.7	3.7	5.2	133.	133.	-2.9	9.2
25	5.4	185.4	-1.2	17.53	5.4	3.1	4.29	7.2	6.9	6.9	5.3	114.	47.	-1.6	9.9

TABLE 3-7. MAY 23, OFF AXIS, FACE-ON, 3 MIN.

## LUVELACE SHOCK TUBE TEST

23 MAY 79

OFF AXIS, FACE-ON

3 MIN BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		REFL	MAX	REFL	TIME	EST	AVE		ADUR	BDUR	EST	TOT		PUS
	PSI	DB	PSI	MS	PSI	PSI	PSI	MS	MS	PSI	PSI	PSI	MS	MS	MS	IMP	IMP	IMP
1	11.5	191.9	-0.7	18.66	11.5	5.2	5.2	4.52	4.52	5.1	5.0	5.0	9.3	22.	80.	0.3	14.3	
2	10.4	191.1	-0.8	26.06	10.4	4.9	4.9	2.99	2.99	5.3	5.2	5.2	8.1	23.	91.	0.8	14.1	
3	12.0	192.3	-0.7	12.68	12.0	5.0	5.0	3.51	3.51	5.0	4.9	4.9	9.5	6.	65.	0.7	14.4	
4	9.9	190.6	-0.7	25.74	9.9	4.5	4.5	3.01	3.01	5.0	4.9	4.9	8.9	9.	66.	-0.1	13.9	
5	8.4	189.6	-0.7	18.68	8.4	5.2	5.2	2.68	2.68	5.1	5.1	5.1	9.4	58.	80.	1.0	14.4	
6	10.3	191.0	-1.3	0.00	10.3	5.4	5.4	3.36	3.36	4.7	4.7	4.7	9.3	24.	101.	1.0	14.2	
7	10.7	191.3	-0.8	18.79	10.7	4.9	4.9	4.60	4.60	4.8	4.8	4.8	9.2	21.	71.	4.5	14.4	
8	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
9	8.6	189.5	-0.8	18.21	8.6	5.3	5.3	2.92	2.92	5.1	5.0	5.0	9.4	24.	66.	3.7	15.0	
10	10.2	190.9	-0.8	25.94	10.2	5.1	5.1	2.53	2.53	5.1	5.0	5.0	9.3	21.	65.	2.1	14.5	
11	11.6	192.0	-0.6	25.83	11.6	5.9	5.9	2.40	2.40	5.2	5.1	5.1	9.0	5.	75.	-1.1	15.0	
12	10.3	191.0	-0.7	35.30	10.3	4.8	4.8	3.39	3.39	4.8	4.8	4.8	9.2	25.	135.	-2.5	14.0	
13	10.5	191.2	-0.8	18.33	10.5	5.0	5.0	4.44	4.44	5.1	5.0	5.0	9.3	23.	66.	-5.1	14.0	
14	10.7	191.3	-0.8	31.36	10.7	5.2	5.2	3.46	3.46	5.2	5.1	5.1	9.3	23.	73.	1.3	14.9	
15	10.2	190.9	-0.8	25.23	10.2	7.4	7.4	1.73	1.73	5.3	5.2	5.2	6.1	7.	87.	-1.1	14.0	
16	10.8	191.4	-0.8	14.82	10.8	4.1	4.1	2.60	2.60	5.2	5.1	5.1	9.3	7.	72.	6.9	14.9	
17	10.4	191.1	-0.8	25.39	10.4	6.0	6.0	2.39	2.39	5.5	5.3	5.3	8.7	8.	57.	-1.5	14.7	
18	12.3	192.5	-0.8	13.69	12.3	5.5	5.5	2.54	2.54	5.4	5.3	5.3	9.0	7.	58.	8.2	14.6	
19	11.0	191.6	-0.7	15.46	11.0	5.6	5.6	2.96	2.96	5.3	5.2	5.2	9.1	7.	73.	-2.7	14.5	
20	12.1	192.4	-0.7	18.31	12.1	5.1	5.1	4.56	4.56	5.0	5.0	5.0	9.3	6.	67.	0.8	14.5	
21	12.1	192.4	-0.8	18.23	12.1	5.3	5.3	3.74	3.74	5.0	4.9	4.9	9.3	24.	81.	-4.3	14.2	
22	11.2	191.8	-9.1	0.00	11.2	5.7	5.7	2.44	2.44	5.5	5.4	5.4	9.3	22.	65.	11.6	16.1	
23	11.5	192.0	-0.8	14.69	11.5	4.9	4.9	3.06	3.06	5.1	5.0	5.0	9.1	24.	64.	-1.8	14.2	
24	11.5	192.0	-0.8	26.18	11.5	5.0	5.0	2.89	2.89	4.9	4.8	4.8	9.3	7.	75.	-2.0	14.6	
25	11.6	192.0	-0.8	18.85	11.6	5.2	5.2	4.54	4.54	5.2	5.1	5.1	9.6	7.	68.	1.4	14.3	

TABLE 3-8. MAY 23, OFF AXIS, GRAZING, 3 MIN.

## LOVELACE SHOCK TUBE TEST

23 MAY 79

OFF AXIS, GRAZING

3 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		TIME		INIT		REFL		TIME		EST		AVE		ADUR		BDUR		EST		TUT		PUS	
	PSI	DB	MIN	MS	MAX	PSI	MAX	PSI	REFL	MS	MAX	PSI	EST	PSI	MS	MS	MS	MS	BDUR	MS	IMP	IMP	IMP	IMP
1	3.8	182.2	-1.1	0.29	3.8	0.3	14.05	0.4	0.3	0.0	0.0	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	-0.3	0.0	0.0	0.0
2	5.7	185.9	-1.0	26.33	5.7	3.2	3.02	4.0	3.9	8.0	47.	91.	-12.8	10.5	47.	47.	47.	47.	47.	47.	-12.8	10.5	10.5	10.5
3	5.5	185.6	-1.0	25.74	5.5	2.6	3.46	3.9	3.9	7.9	57.	83.	-11.3	10.4	57.	57.	57.	57.	57.	57.	-11.3	10.4	10.4	10.4
4	5.6	185.8	-0.9	26.23	5.6	2.8	3.04	3.9	3.9	8.0	47.	82.	-11.1	10.0	47.	47.	47.	47.	47.	47.	-11.1	10.0	10.0	10.0
5	5.4	185.4	-1.0	25.49	5.4	2.8	2.70	3.9	3.9	7.5	56.	81.	-14.0	10.3	56.	56.	56.	56.	56.	56.	-14.0	10.3	10.3	10.3
6	5.4	185.3	-0.9	32.67	5.4	3.5	3.29	3.8	3.8	6.2	44.	92.	-7.5	9.9	44.	44.	44.	44.	44.	44.	-7.5	9.9	9.9	9.9
7	5.2	185.1	-1.0	26.43	5.2	2.6	3.14	3.8	3.8	7.8	57.	95.	-7.5	10.2	57.	57.	57.	57.	57.	57.	-7.5	10.2	10.2	10.2
8	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9	5.5	185.5	-1.0	25.65	5.5	2.5	3.07	4.0	3.9	7.9	57.	92.	-10.6	10.3	57.	57.	57.	57.	57.	57.	-10.6	10.3	10.3	10.3
10	5.5	185.5	-0.9	25.75	5.5	2.9	3.08	3.9	3.9	7.5	55.	57.	-12.3	10.2	55.	55.	55.	55.	55.	55.	-12.3	10.2	10.2	10.2
11	5.3	185.3	-1.0	25.59	5.3	3.2	2.43	4.0	3.9	5.6	54.	82.	-9.4	9.8	54.	54.	54.	54.	54.	54.	-9.4	9.8	9.8	9.8
12	5.1	184.9	-1.0	32.13	5.1	2.7	3.31	3.8	3.8	7.8	57.	77.	-14.2	9.8	57.	57.	57.	57.	57.	57.	-14.2	9.8	9.8	9.8
13	5.7	185.8	-0.9	30.16	5.7	2.8	3.06	3.9	3.9	6.4	47.	65.	-8.9	9.7	47.	47.	47.	47.	47.	47.	-8.9	9.7	9.7	9.7
14	5.9	186.2	-0.9	30.93	5.9	2.7	3.39	4.1	4.1	7.9	55.	74.	-9.2	10.4	55.	55.	55.	55.	55.	55.	-9.2	10.4	10.4	10.4
15	5.6	185.6	-1.1	25.41	5.6	4.3	1.76	4.0	4.0	5.9	56.	92.	-11.7	10.1	56.	56.	56.	56.	56.	56.	-11.7	10.1	10.1	10.1
16	5.8	186.0	-1.0	26.62	5.8	2.7	3.14	3.9	3.9	5.6	44.	133.	-7.7	9.7	44.	44.	44.	44.	44.	44.	-7.7	9.7	9.7	9.7
17	5.8	186.0	-1.0	26.27	5.8	3.3	2.41	4.2	4.1	5.6	55.	92.	-10.9	10.0	55.	55.	55.	55.	55.	55.	-10.9	10.0	10.0	10.0
18	6.0	186.4	-1.0	25.43	6.0	3.1	2.56	4.0	4.0	7.7	45.	93.	-10.7	10.5	45.	45.	45.	45.	45.	45.	-10.7	10.5	10.5	10.5
19	5.7	185.8	-0.9	26.68	5.7	2.8	2.99	4.0	4.0	8.0	58.	93.	-13.9	10.3	58.	58.	58.	58.	58.	58.	-13.9	10.3	10.3	10.3
20	5.2	185.0	-0.9	30.34	5.2	2.5	3.21	3.9	3.9	8.4	57.	85.	-8.4	10.7	57.	57.	57.	57.	57.	57.	-8.4	10.7	10.7	10.7
21	5.8	185.0	-1.0	33.73	5.8	2.5	3.74	4.0	3.9	8.7	46.	82.	-9.9	10.4	46.	46.	46.	46.	46.	46.	-9.9	10.4	10.4	10.4
22	6.0	186.3	-1.1	25.52	6.0	3.1	2.48	4.1	4.1	5.8	56.	84.	-11.0	10.2	56.	56.	56.	56.	56.	56.	-11.0	10.2	10.2	10.2
23	5.5	185.5	-1.0	25.04	5.5	2.9	3.08	4.0	3.9	6.3	55.	81.	-9.8	9.8	55.	55.	55.	55.	55.	55.	-9.8	9.8	9.8	9.8
24	5.2	185.0	-1.0	25.89	5.2	2.6	3.16	3.8	3.7	8.1	56.	93.	-9.2	10.5	56.	56.	56.	56.	56.	56.	-9.2	10.5	10.5	10.5
25	5.7	185.9	-1.7	9.00	5.7	3.7	8.49	4.0	3.9	8.0	56.	83.	-7.6	10.3	56.	56.	56.	56.	56.	56.	-7.6	10.3	10.3	10.3

TABLE 3-9. MAY 24, OFF AXIS, FACE-ON, 1 MIN.

LOVELACE SHOCK TUBE TEST

23 MAY 79

OFF AXIS, FACE-ON

1 MIN BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		INIT	REFL		TIME	EST		AVE	ADUR	ADUR	MS	EST	BDUR	TDF	POS
	PSI	OB	PSI	MIN	MS	MAX	MAX	PSI	MS	MAX	PSI	PSI	MS	MS	MS	PSI	MS	IMP	IMP
1	10.9	191.5	-0.8	14.93	10.9	5.1	2.77	5.3	5.2	10.4	22.0	67.0	10.4	22.0	67.0	5.3	67.0	-1.0	16.5
2	12.8	192.9	-0.8	14.58	12.8	4.5	3.45	5.7	5.6	9.8	8.0	59.0	9.8	8.0	59.0	5.7	59.0	4.7	17.0
3	13.1	193.1	-0.8	19.28	13.1	6.0	2.48	5.7	5.6	9.5	8.0	62.0	9.5	8.0	62.0	5.7	62.0	2.0	16.2
4	13.2	193.2	-0.9	14.68	13.2	7.9	2.11	5.5	5.5	9.5	5.0	65.0	9.5	5.0	65.0	5.5	65.0	0.6	16.7
5	13.3	193.2	-0.8	34.84	13.3	5.0	3.07	5.7	5.7	10.1	7.0	60.0	10.1	7.0	60.0	5.7	60.0	-0.5	16.4
6	12.1	192.4	-0.9	14.68	12.1	6.1	2.46	5.4	5.4	9.5	22.0	76.0	9.5	22.0	76.0	5.4	76.0	-4.7	15.9
7	13.4	193.3	-0.7	15.60	13.4	6.0	2.90	5.6	5.6	9.7	7.0	57.0	9.7	7.0	57.0	5.6	57.0	3.2	16.8
8	12.5	192.7	-0.8	14.79	12.5	5.1	2.80	5.8	5.7	9.7	7.0	61.0	9.7	7.0	61.0	5.8	61.0	-1.4	16.6
9	11.7	192.1	-0.8	15.76	11.7	4.8	3.17	5.6	5.5	10.1	23.0	59.0	10.1	23.0	59.0	5.6	59.0	-2.6	16.2
10	13.3	193.2	-0.8	14.59	13.3	6.8	2.28	5.6	5.6	9.7	7.0	58.0	9.7	7.0	58.0	5.6	58.0	-2.2	17.0
11	12.4	192.6	-0.8	14.74	12.4	6.5	2.86	5.8	5.7	9.6	7.0	58.0	9.6	7.0	58.0	5.8	58.0	-0.9	16.6
12	14.0	193.7	-0.8	26.38	14.0	5.3	2.76	6.0	5.9	9.8	23.0	57.0	9.8	23.0	57.0	6.0	57.0	4.8	16.9
13	12.2	192.5	-0.8	14.76	12.2	6.8	2.49	5.7	5.6	9.7	7.0	58.0	9.7	7.0	58.0	5.7	58.0	-1.4	16.5
14	13.3	193.2	-0.8	14.78	13.3	5.1	2.53	5.7	5.6	11.0	5.0	62.0	11.0	5.0	62.0	5.7	62.0	-2.1	16.6
15	13.5	193.3	-0.8	26.04	13.5	5.4	3.09	5.6	5.5	9.6	8.0	67.0	9.6	8.0	67.0	5.6	67.0	-3.0	16.5
16	12.3	192.5	-0.8	14.81	12.3	7.5	2.17	6.2	6.1	9.6	5.0	59.0	9.6	5.0	59.0	6.2	59.0	3.1	17.8
17	13.5	193.4	-0.8	14.94	13.5	5.1	2.70	5.8	5.7	9.7	24.0	65.0	9.7	24.0	65.0	5.8	65.0	-1.5	16.4
18	12.5	192.7	-0.8	14.73	12.5	5.5	2.67	5.6	5.6	9.8	22.0	62.0	9.8	22.0	62.0	5.6	62.0	0.9	17.0
19	12.6	192.7	-0.7	15.16	12.6	4.3	3.38	5.3	5.3	10.4	21.0	65.0	10.4	21.0	65.0	5.3	65.0	4.7	16.6
20	13.5	193.3	-0.8	13.73	13.5	7.2	2.26	5.7	5.6	9.4	7.0	67.0	9.4	7.0	67.0	5.7	67.0	-0.6	16.7
21	12.3	192.6	-0.8	14.81	12.3	5.1	2.70	5.6	5.6	9.7	7.0	65.0	9.7	7.0	65.0	5.6	65.0	-2.6	16.5
22	13.8	193.6	-0.9	14.92	13.8	5.9	2.48	5.9	5.8	9.7	5.0	56.0	9.7	5.0	56.0	5.9	56.0	-0.9	16.7
23	12.6	192.7	-0.9	15.21	12.6	5.6	3.23	5.5	5.4	10.2	22.0	66.0	10.2	22.0	66.0	5.5	66.0	-0.8	15.9
24	12.6	192.7	-0.8	15.53	12.6	4.3	3.56	5.2	5.2	9.6	8.0	69.0	9.6	8.0	69.0	5.2	69.0	-3.5	15.7
25	11.6	192.1	-1.0	14.78	11.6	7.2	2.15	5.3	5.3	9.6	7.0	65.0	9.6	7.0	65.0	5.3	65.0	-3.2	16.8

TABLE 3-10. MAY 24, OFF AXIS, GRAZING, 1 MIN.

## LOVELACE SHOCK TUBE TEST

24 MAY 79

OFF AXIS, GRAZING  
1 MIN BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		INIT	REFL		EST	AVE		ADUR	BDUR		EST	TDR		POS
	PSI	DB	PSI	MS	MS	PSI	MAX	PSI		MAX	PSI	MS	MS	MS		IMP	MS--	
1	5.2	185.0	-1.0	18.66		5.2	3.5	3.13	3.9	3.9	3.9	5.8	82.	82.	117.	-0.5	9.5	
2	5.4	185.4	-1.2	18.66		5.4	2.6	3.86	4.1	4.0	4.0	8.6	82.	82.	110.	-3.3	10.6	
3	5.4	185.4	-1.0	15.21		5.4	3.0	2.51	4.1	4.0	4.0	5.7	55.	55.	82.	-1.9	9.7	
4	5.8	186.1	-1.0	14.61		5.8	3.6	2.15	4.0	4.0	4.0	5.4	65.	65.	94.	-2.9	9.5	
5	5.8	186.1	-1.1	29.89		5.8	2.9	3.13	4.2	4.1	4.1	8.5	58.	58.	116.	-3.5	10.5	
6	5.6	185.7	-1.1	14.76		5.6	3.4	2.48	3.9	3.9	3.9	7.9	45.	45.	96.	-2.0	10.1	
7	0.6	166.6	-1.6	0.00		0.6	0.2	16.14	0.1	0.1	0.1	0.0	156.	156.	156.	0.4	0.0	
8	5.6	185.7	-1.0	15.43		5.6	3.1	2.82	4.1	4.0	4.0	7.9	72.	72.	115.	-1.7	10.3	
9	5.3	185.1	-1.1	18.06		5.3	2.5	3.62	4.0	4.0	4.0	8.2	82.	82.	151.	0.3	10.1	
10	5.3	185.3	-1.2	14.49		5.3	3.2	2.34	4.0	3.9	3.9	5.8	82.	82.	116.	-2.7	9.5	
11	5.4	185.5	-1.0	14.58		5.4	3.3	2.88	4.1	4.0	4.0	5.9	48.	48.	115.	-2.2	9.4	
12	5.7	185.8	-1.0	25.97		5.7	2.7	2.79	4.1	4.1	4.1	5.8	57.	57.	99.	-1.5	9.4	
13	5.5	185.6	-1.0	31.78		5.5	3.3	3.11	4.0	4.0	4.0	8.5	56.	56.	100.	-0.6	10.4	
14	5.4	185.4	-1.0	15.21		5.4	3.0	2.57	4.0	4.0	4.0	5.7	59.	59.	101.	-0.2	9.4	
15	5.5	185.5	-1.0	26.09		5.5	3.2	3.11	3.9	3.9	3.9	8.5	61.	61.	116.	-1.9	10.5	
16	5.9	186.1	-1.0	14.71		5.9	3.7	2.21	4.3	4.2	4.2	8.3	55.	55.	88.	-1.3	11.0	
17	5.1	185.0	-1.0	25.69		5.1	3.0	2.72	4.0	3.9	3.9	5.3	55.	55.	116.	-2.7	9.0	
18	5.3	185.2	-1.0	31.83		5.3	2.9	2.68	4.0	3.9	3.9	5.8	80.	80.	116.	0.1	9.6	
19	5.2	185.0	-1.0	15.32		5.2	3.0	3.66	3.8	3.8	3.8	8.6	65.	65.	116.	-3.6	10.2	
20	5.4	185.3	-1.0	15.79		5.4	3.4	2.29	4.1	4.0	4.0	5.7	82.	82.	116.	-1.4	9.7	
21	5.3	185.2	-1.1	18.98		5.3	2.7	3.11	3.9	3.9	3.9	7.7	65.	65.	94.	-3.6	10.2	
22	6.0	185.3	-1.0	32.58		6.0	3.2	2.61	4.2	4.1	4.1	7.9	45.	45.	80.	-0.9	10.4	
23	5.4	185.5	-1.2	15.45		5.4	2.5	3.26	3.8	3.8	3.8	7.8	66.	66.	100.	-11.8	9.4	
24	5.0	184.8	-1.0	18.61		5.0	2.0	3.57	3.9	3.9	3.9	8.9	82.	82.	114.	-0.1	10.4	

TABLE 3-11. MAY 24, ON AXIS, FACE-ON, 1 MIN.

## LOVELACE SHOCK TUBE TEST

24 MAY 79

ON AXIS, FACE-ON

1 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		INIT	REFL	MAX	REFL	TIME	EST	AVE	ADUR		HDUR	EST	BDUR	TUF		POS
	PSI	OB	PSI	MS	PSI	PSI	PSI	PSI	MS	PSI	PSI	PSI	MS	MS	MS	MS	MS	JAP	JAP	--PSI-MS--
1	11.9	192.2	-0.8	14.09	11.9	4.9	3.84	4.9	3.84	4.9	4.9	4.9	7.1	23.	23.	150.	0.6	15.0	0.6	15.0
2	12.3	192.5	-1.0	15.07	12.3	4.4	4.51	5.4	4.51	5.4	5.3	5.3	9.0	8.	8.	77.	-2.0	16.1	-2.0	16.1
3	11.9	192.2	-0.8	14.05	11.9	5.4	2.48	5.2	2.48	5.2	5.1	5.1	6.4	23.	23.	93.	-2.3	14.8	-2.3	14.8
4	13.2	193.2	-0.8	13.66	13.2	6.4	2.08	5.3	2.08	5.3	5.3	5.3	5.5	21.	21.	75.	-5.1	14.6	-5.1	14.6
5	12.9	193.0	-0.9	34.20	12.9	6.1	4.12	5.5	4.12	5.5	5.5	5.5	8.9	37.	37.	65.	1.5	16.2	1.5	16.2
6	12.4	192.6	-0.9	13.95	12.4	5.4	3.78	5.2	3.78	5.2	5.1	5.1	6.9	8.	8.	136.	0.9	15.1	0.9	15.1
7	12.4	192.6	-0.9	14.84	12.4	5.2	2.91	5.5	2.91	5.5	5.3	5.3	8.5	5.	5.	61.	1.2	15.7	1.2	15.7
8	11.9	192.3	-0.9	13.71	11.9	5.3	2.83	5.3	2.83	5.3	5.1	5.1	6.7	7.	7.	85.	-1.8	15.0	-1.8	15.0
9	12.2	192.5	-0.9	15.09	12.2	5.3	4.28	5.1	4.28	5.1	4.9	4.9	7.0	8.	8.	137.	0.1	14.6	0.1	14.6
10	11.8	192.2	-0.8	33.36	11.8	5.5	2.28	5.2	2.28	5.2	5.1	5.1	5.9	24.	24.	67.	-2.3	14.9	-2.3	14.9
11	13.3	193.2	-1.0	19.26	13.3	4.6	2.83	5.6	2.83	5.6	5.6	5.6	8.7	7.	7.	80.	0.3	15.9	0.3	15.9
12	12.6	192.7	-0.9	32.39	12.6	5.5	3.86	5.4	3.86	5.4	5.3	5.3	7.1	5.	5.	82.	-3.9	14.6	-3.9	14.6
13	12.6	192.7	-0.9	13.91	12.6	6.1	3.71	5.1	3.71	5.1	5.0	5.0	6.6	5.	5.	77.	-0.3	14.9	-0.3	14.9
14	12.7	192.8	-0.8	31.98	12.7	6.2	3.99	5.4	3.99	5.4	5.2	5.2	6.9	8.	8.	102.	6.8	15.1	6.8	15.1
15	11.9	192.2	-0.9	32.37	11.9	4.8	4.27	5.1	4.27	5.1	5.0	5.0	9.3	24.	24.	83.	1.4	16.0	1.4	16.0
16	13.4	193.3	-0.9	13.38	13.4	6.9	2.14	5.6	2.14	5.6	5.4	5.4	5.5	5.	5.	81.	2.5	15.5	2.5	15.5
17	11.7	192.1	-0.9	13.85	11.7	5.0	3.98	5.1	3.98	5.1	4.9	4.9	8.8	21.	21.	102.	-1.8	15.6	-1.8	15.6
18	12.3	192.5	-0.9	18.94	12.3	4.4	2.65	4.9	2.65	4.9	4.8	4.8	5.6	23.	23.	136.	-2.5	14.4	-2.5	14.4
19	12.2	192.5	-1.0	14.06	12.2	5.2	4.35	5.0	4.35	5.0	4.9	4.9	8.8	24.	24.	101.	-2.6	15.4	-2.6	15.4
20	13.1	193.1	-0.9	13.45	13.1	5.5	3.69	5.3	3.69	5.3	5.2	5.2	5.9	9.	9.	66.	-2.9	15.0	-2.9	15.0
21	12.0	192.3	-0.9	14.07	12.0	4.9	3.84	5.0	3.84	5.0	4.9	4.9	6.8	23.	23.	89.	-4.0	14.9	-4.0	14.9
22	12.0	192.3	-0.9	14.90	12.0	6.0	2.49	5.2	2.49	5.2	5.1	5.1	5.8	21.	21.	137.	-3.7	14.6	-3.7	14.6
23	12.8	192.9	-0.9	15.18	12.8	4.5	4.42	5.2	4.42	5.2	5.1	5.1	5.9	8.	8.	96.	-2.5	14.1	-2.5	14.1
24	11.7	192.1	-0.9	15.04	11.7	4.3	4.78	4.9	4.78	4.9	4.8	4.8	9.7	23.	23.	136.	-0.4	15.5	-0.4	15.5
25	11.0	191.6	-1.0	31.64	11.0	6.8	2.11	4.8	2.11	4.8	4.8	4.8	5.8	20.	20.	137.	2.4	15.1	2.4	15.1



LOVELACE: SHOCK TIME TEST

### ON AXIS, GRAZING;

1 MIN DEF TW FID S40RS

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TABLE 3-13. MAY 25, OFF AXIS, FACE-ON, 20 SEC.

## LOVELACE SHOCK TUBE TEST

25 MAY 79

OFF AXIS, FACE-ON

20 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		INIT	REFL	TIME	EST	AVE	ADUR	BDUR	EST	RDRUR	TOT	POS
	PSI	DB		MS	PSI											
1	11.9	192.3	-0.8	25.75	11.9	6.6	2.38	5.4	5.3	9.6	21.	74.	0.0	16.3		
2	13.1	193.1	-0.9	18.87	13.1	4.3	3.76	5.4	5.3	8.6	7.	85.	-4.1	14.4		
3	12.7	192.8	-0.9	14.23	12.7	5.8	2.73	5.1	5.0	9.4	6.	74.	-0.9	15.1		
4	11.3	191.8	-1.1	17.00	11.3	5.4	3.31	5.2	5.1	8.6	7.	64.	-2.7	14.9		
5	5.2	185.1	-1.0	14.16	5.2	4.6	3.01	3.3	3.2	9.5	81.	149.	-0.8	16.0		
6	9.8	190.6	-0.8	18.29	9.8	4.5	3.94	4.2	4.2	8.4	24.	108.	0.1	15.2		
7	12.4	192.6	-0.9	13.11	12.4	6.1	3.57	5.2	5.1	8.8	6.	105.	-6.5	15.1		
8	11.3	191.8	-0.9	34.09	11.3	5.1	4.13	4.5	4.5	8.8	25.	92.	-1.8	14.7		
9	9.4	190.2	-0.9	17.08	9.4	6.2	3.96	4.4	4.3	8.8	9.	150.	-2.1	15.4		
10	9.8	190.6	-0.9	14.17	9.8	8.0	2.92	4.4	4.4	8.9	23.	73.	-2.7	15.2		
11	9.6	190.4	-0.8	39.33	9.6	6.1	3.79	4.4	4.3	8.8	9.	138.	-1.3	15.8		
12	9.7	190.4	-1.0	14.88	9.7	4.1	2.97	4.8	4.7	8.3	55.	80.	-2.7	14.6		
13	9.7	190.5	-0.9	14.95	9.7	5.1	3.67	4.4	4.4	8.6	25.	108.	-2.2	15.0		
14	8.3	189.1	-1.0	14.24	8.3	6.8	3.39	3.6	3.6	8.4	24.	167.	-3.4	14.9		
15	10.8	191.4	-1.0	17.13	10.8	6.9	3.09	4.4	4.4	8.6	7.	83.	-3.5	15.5		
16	12.7	192.8	-1.0	13.98	12.7	8.1	3.13	5.2	5.1	7.9	6.	70.	-1.6	14.6		
17	12.3	192.6	-1.0	14.06	12.3	6.3	3.02	4.9	4.8	8.6	6.	88.	-1.3	15.5		
18	10.0	190.7	-1.0	13.94	10.0	7.7	2.67	4.3	4.3	8.6	6.	136.	-6.8	14.8		
19	8.8	189.6	-1.0	19.54	8.8	5.1	5.43	4.0	3.8	9.5	59.	136.	-2.9	16.2		
20	10.1	190.8	-0.9	15.01	10.1	8.2	2.51	4.4	4.3	9.0	53.	133.	0.0	15.4		
21	11.2	191.7	-1.0	17.15	11.2	8.9	3.20	4.7	4.7	9.6	8.	81.	0.0	16.6		
22	10.6	191.3	-0.9	13.78	10.6	7.6	2.92	4.6	4.6	8.4	22.	70.	6.0	15.5		
23	10.6	191.2	-1.0	17.14	10.6	6.3	3.17	4.4	4.3	8.6	23.	96.	2.0	15.4		
24	9.5	190.3	-1.0	15.00	9.5	8.9	2.79	3.9	3.9	8.3	15.	136.	-0.6	15.2		
25	8.6	189.4	-2.9	0.21	8.6	8.6	17.83	0.7	0.3	0.0	14.	156.	0.0	15.0		

TABLE 3-14. MAY 25, OFF AXIS, GRAZING, 20 SEC.

## LOVELACE SHOCK TUBE TEST

25 MAY 79

OFF AXIS, GRAZING

20 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN PSI	TIME MIN MS		REFL MAX PSI	TIME REFU MS	EST MAX PSI	AVE EST PSI	ADUR MS		RMDR MS	EST BDUR MS	FDF IMP	POS 1-AP
	PSI	DR		MS	PSI					MS	MS				
1	5.3	185.2	-1.0	25.66	5.3	3.0	2.41	3.9	3.9	6.2	110.	151.	0.2	9.8	
2	5.4	185.3	-1.1	17.21	5.4	2.6	4.04	3.7	3.7	7.5	56.	150.	-10.1	9.2	
3	5.3	185.2	-1.1	14.37	5.3	3.4	2.85	3.7	3.6	5.2	114.	148.	-3.5	8.9	
4	5.3	185.2	-1.0	17.12	5.3	3.0	3.31	3.8	3.7	8.2	54.	149.	-3.5	10.0	
5	3.8	182.2	-1.2	18.14	3.8	2.6	2.97	2.5	2.4	7.5	106.	154.	-6.9	9.8	
6	3.8	182.4	-1.0	14.91	3.8	2.5	3.99	2.9	2.9	8.2	113.	144.	-3.2	10.2	
7	5.0	184.7	-0.9	19.49	5.0	3.2	3.72	3.6	3.5	8.4	81.	112.	-3.0	10.5	
8	4.9	184.5	-1.0	18.41	4.9	3.3	4.15	3.3	3.3	8.3	55.	136.	-4.7	10.2	
9	4.6	184.0	-1.0	17.21	4.6	3.3	3.94	3.2	3.1	8.7	56.	149.	-5.0	10.7	
10	4.2	183.2	-1.1	14.53	4.1	4.2	2.92	3.1	3.0	8.0	90.	143.	-4.5	10.2	
11	4.4	183.6	-1.1	17.81	4.4	3.0	3.79	3.1	3.1	8.3	92.	150.	-5.0	10.7	
12	4.7	184.2	-1.0	14.39	4.7	3.4	2.98	3.4	3.3	8.1	79.	144.	-8.6	10.1	
13	4.3	183.3	-1.0	18.50	4.3	3.0	3.66	3.1	3.1	8.1	55.	151.	-6.3	10.4	
14	3.6	182.0	-1.0	18.33	3.4	3.6	3.39	2.5	2.5	8.3	142.	151.	-4.2	10.5	
15	4.4	183.7	-1.0	14.22	4.4	4.0	3.10	3.1	3.1	8.2	94.	135.	-4.4	10.7	
16	5.0	184.8	-1.0	17.40	5.0	4.6	3.13	3.6	3.5	6.9	70.	128.	-6.8	9.7	
17	5.0	184.8	-1.0	29.13	5.0	3.6	3.01	3.5	3.4	7.3	64.	128.	-3.0	10.5	
18	4.6	184.0	-1.0	14.25	4.6	4.2	2.66	3.1	3.0	7.8	92.	149.	-4.6	10.4	
19	4.0	182.9	-1.2	19.43	4.0	2.7	5.92	3.0	3.0	4.5	92.	145.	-5.4	10.2	
20	5.3	185.2	-1.0	28.34	4.6	5.3	2.51	3.2	3.2	5.4	53.	135.	-5.7	9.6	
21	4.7	184.1	-1.1	29.11	4.7	4.4	3.18	3.3	3.3	8.2	91.	136.	-5.0	10.6	
22	4.9	184.6	-1.1	32.93	4.9	4.3	2.91	3.4	3.4	8.0	78.	135.	-3.5	10.4	
23	4.5	183.8	-1.0	14.38	4.5	3.9	3.19	3.2	3.1	8.1	90.	136.	-4.3	10.3	
24	5.0	184.7	-1.0	14.39	3.5	5.0	2.79	2.7	2.7	8.0	70.	151.	-5.5	10.4	
25	3.2	180.7	-1.1	17.60	3.2	2.5	3.89	3.3	3.2	8.1	147.	125.	-2.3	10.1	

TABLE 3-15. MAY 25, ON AXIS, FACE-ON, 20 SEC.

## LOVELACE SHOCK TUBE TEST

25 MAY 79

ON AXIS, FACE-ON

20 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		REFL	MAX	REFL	TIME	EST	AVE	ADUR	BDUR	EST	ADUR	TOT		PUS
	PSI	DB	PSI	MS	PSI	PSI	PSI	MS	PSI	PSI	PSI	MS	MS	MS	MS	IMP	IMP	IMP
1	11.8	192.2	-0.9	13.91	11.8	5.0	2.33	4.8	4.8	4.8	4.8	5.9	23.	147.	147.	-0.1	14.7	--PSI-MS--
2	11.6	192.0	-0.8	14.29	11.6	5.0	4.76	5.5	5.4	5.4	5.4	7.8	10.	66.	66.	3.5	14.6	
3	9.7	190.5	-0.9	26.11	9.7	4.3	2.73	4.1	4.0	4.0	4.0	6.8	10.	144.	144.	0.4	14.5	
4	10.5	191.2	-0.9	13.58	10.5	7.3	3.33	4.8	4.8	4.8	4.8	6.8	9.	133.	133.	0.1	14.5	
5	12.8	192.9	-1.0	13.95	12.8	5.5	2.99	5.5	5.3	5.3	5.3	8.5	6.	65.	65.	-1.4	15.2	
6	11.0	191.6	-0.8	32.98	11.0	4.4	4.87	5.1	4.9	4.9	4.9	7.6	55.	73.	73.	-0.2	14.7	
7	11.9	192.3	-0.9	13.31	11.9	4.6	4.84	5.0	5.0	5.0	5.0	7.8	9.	97.	97.	0.5	15.1	
8	11.8	192.2	-0.8	17.46	11.8	5.5	4.20	4.8	4.8	4.8	4.8	8.0	24.	133.	133.	-2.4	14.3	
9	10.9	191.5	-1.0	13.81	10.9	6.0	4.02	4.7	4.7	4.7	4.7	8.1	24.	132.	132.	-1.3	15.3	
10	12.6	192.7	-1.0	26.37	12.6	6.6	2.91	5.5	5.2	5.2	5.2	6.4	9.	123.	123.	-5.1	14.6	
11	8.8	189.7	-0.9	18.80	8.8	3.9	3.97	4.2	4.2	4.2	4.2	7.8	59.	137.	137.	-1.3	15.7	
12	10.6	191.2	-1.1	14.19	10.6	7.6	2.95	4.5	4.4	4.4	4.4	7.5	22.	133.	133.	-1.7	14.8	
13	11.9	192.3	-0.9	13.76	11.9	5.2	3.78	5.1	5.0	5.0	5.0	7.8	9.	87.	87.	-1.7	15.1	
14	14.1	193.7	-0.9	13.53	14.1	6.5	3.32	5.8	5.7	5.7	5.7	7.3	24.	71.	71.	-0.8	14.8	
15	10.4	191.1	-0.9	13.11	10.4	8.9	3.03	4.7	4.6	4.6	4.6	6.9	40.	88.	88.	-0.1	15.4	
16	11.4	191.9	-0.9	30.01	11.4	7.1	3.07	5.5	5.3	5.3	5.3	6.8	23.	84.	84.	-1.6	14.6	
17	11.9	192.2	-0.9	12.92	11.9	9.0	3.03	5.3	5.3	5.3	5.3	7.4	53.	75.	75.	0.8	15.5	
18	11.1	191.7	-0.9	13.28	11.1	7.1	2.65	4.9	4.8	4.8	4.8	6.2	54.	133.	133.	1.2	14.9	
19	11.3	191.8	-0.9	18.54	11.3	8.6	5.58	4.9	4.8	4.8	4.8	3.7	11.	97.	97.	2.1	15.5	
20	10.7	191.3	-0.8	13.07	10.7	5.4	2.48	4.7	4.7	4.7	4.7	6.8	22.	104.	104.	0.9	15.2	
21	11.6	192.1	-0.8	13.59	11.6	8.0	3.17	5.6	5.5	5.5	5.5	8.8	22.	66.	66.	-0.1	16.7	
22	11.8	192.2	-1.0	13.24	11.8	7.0	2.89	5.4	5.2	5.2	5.2	7.3	24.	78.	78.	-0.4	15.1	
23	12.8	192.9	-1.0	13.07	12.8	7.3	3.13	5.2	5.0	5.0	5.0	8.0	54.	84.	84.	-0.1	15.0	
24	11.3	191.8	-0.9	12.72	11.3	9.5	2.73	4.6	4.5	4.5	4.5	6.6	56.	136.	136.	-0.3	15.0	
25	12.6	192.8	-0.8	13.63	12.6	3.7	4.98	5.0	4.9	4.9	4.9	6.7	25.	66.	66.	-2.1	14.8	

TABLE 3-16. MAY 25, ON AXIS, GRAZING, 20 SEC.

## LOVELACE SHOCK TUBE TEST

25 MAY 79

ON AXIS, GRAZING

20 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		INIT	REFL	TIME	EST		AVE	ADUR		HOUR	EST	TOT	
	PSI	DR	PSI	MS	MS	PSI	PSI	MS	MAX	PSI	PSI	MS	MS	MS	BDUR	IMP	IMP
1	5.1	184.8	-1.0	13.56	5.1	2.7	3.73	3.73	3.7	3.7	3.7	5.6	5.6	66.	149.	-7.5	10.7
2	5.9	186.1	-1.0	17.12	5.9	2.8	4.74	4.74	4.0	3.9	3.9	6.0	6.0	115.	150.	13.6	10.2
3	4.3	183.4	-0.9	13.51	4.3	2.7	3.08	3.08	3.4	3.3	3.3	5.4	5.4	152.	152.	20.9	9.6
4	5.1	184.9	-0.9	13.44	5.1	4.0	3.30	3.30	3.8	3.8	3.8	6.4	6.4	105.	151.	13.4	10.9
5	6.6	187.1	-1.0	13.89	6.6	3.7	3.01	3.01	4.0	3.4	3.4	6.8	6.8	113.	152.	30.3	11.1
6	5.1	184.9	-1.0	18.58	5.1	2.3	4.66	4.66	3.6	3.5	3.5	7.6	7.6	139.	153.	35.5	10.8
7	5.3	185.2	-0.9	13.28	5.3	2.9	1.59	1.59	3.6	3.5	3.5	6.6	6.6	153.	155.	29.1	10.8
8	4.7	184.2	-0.9	12.84	4.7	2.9	1.76	1.76	3.4	3.4	3.4	7.0	7.0	153.	153.	28.7	10.7
9	4.5	183.9	-0.9	18.46	4.5	3.3	1.58	1.58	3.4	3.4	3.4	7.3	7.3	156.	156.	38.4	10.9
10	5.4	185.4	-1.1	14.00	5.4	4.4	2.88	2.88	3.9	3.7	3.7	6.2	6.2	150.	151.	26.0	9.9
11	4.5	183.8	-0.9	18.50	4.5	2.5	5.00	5.00	6.1	5.7	5.7	6.4	6.4	155.	128.	44.8	11.4
12	4.5	183.9	-1.1	14.41	4.5	3.7	2.94	2.94	3.4	3.3	3.3	6.4	6.4	154.	154.	30.9	10.2
13	5.3	185.2	-0.9	14.31	5.3	2.7	4.94	4.94	3.6	3.5	3.5	7.2	7.2	151.	151.	30.5	10.7
14	5.7	185.9	-0.9	13.69	5.7	2.7	3.44	3.44	4.0	4.0	4.0	7.0	7.0	150.	155.	25.9	11.1
15	5.0	184.7	-0.9	14.26	5.0	4.6	3.01	3.01	3.4	3.4	3.4	6.4	6.4	149.	154.	26.0	11.0
16	5.4	185.4	-0.9	29.63	5.4	3.8	3.05	3.05	3.6	3.6	3.6	6.5	6.5	152.	153.	31.9	10.4
17	5.4	185.4	-0.9	14.31	5.4	4.6	3.00	3.00	3.8	3.7	3.7	6.1	6.1	139.	150.	27.7	11.2
18	5.0	184.7	-1.0	14.25	5.0	4.3	2.64	2.64	3.5	3.4	3.4	6.2	6.2	149.	152.	26.8	10.9
19	4.4	183.7	-1.1	19.10	4.4	4.4	5.64	5.64	3.1	3.0	3.0	3.7	3.7	152.	152.	39.4	10.6
20	5.0	184.7	-1.0	13.12	5.0	3.5	2.53	2.53	7.2	6.7	6.7	6.1	6.1	149.	105.	33.9	10.9
21	5.7	185.8	-0.9	12.94	5.7	3.8	3.14	3.14	4.0	3.9	3.9	7.5	7.5	147.	153.	32.9	11.7
22	5.1	184.9	-0.9	12.97	5.1	4.3	2.87	2.87	3.7	3.6	3.6	6.5	6.5	152.	155.	31.0	11.1
23	5.5	185.6	-0.9	12.89	5.5	3.6	3.12	3.12	3.7	3.7	3.7	6.9	6.9	146.	153.	31.5	11.1
24	5.4	185.3	-1.0	12.67	4.4	5.4	2.71	2.71	3.2	3.2	3.2	6.5	6.5	152.	155.	30.6	10.9
25	5.1	184.0	-0.9	18.23	5.1	2.3	1.61	1.61	3.6	3.5	3.5	6.5	6.5	153.	154.	33.2	10.9

TABLE 3-17. MAY 30, OFF AXIS, FACE-ON, 1 MIN.

## LOVELACE SHOCK TUBE TEST

30 MAY 79

OFF AXIS, FACE-ON

1 MIN BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		REFL	TIME	EST	AVE	ADUR	HDDUR	EST	HDDUR	EST	IMP	PUS
	PSI	DR	PSI	MIN	MAX	PSI	MS	MAX	EST	MS	MS	MS	MS	MS	IMP	IMP
1	11.4	191.9	-0.6	15.54	11.4	4.8	2.88	5.5	5.5	9.6	22.	90.	22.	90.	-0.9	16.3
2	12.8	192.9	-0.8	14.01	12.8	4.8	3.63	5.4	5.3	9.9	7.	57.	7.	57.	1.1	16.0
3	11.2	191.8	-0.8	25.27	11.2	5.0	3.06	4.8	4.7	9.6	24.	143.	24.	143.	-7.2	15.5
4	11.0	191.6	-0.9	31.38	11.0	5.0	3.08	5.2	5.2	9.5	23.	57.	23.	57.	-0.1	15.5
5	12.2	192.5	-0.8	26.01	12.2	4.8	4.23	5.3	5.3	10.2	24.	74.	24.	74.	-1.3	16.7
6	10.9	191.5	-0.7	15.84	10.9	5.0	4.69	5.3	5.2	9.5	23.	92.	23.	92.	-1.6	15.8
7	12.1	192.4	-0.9	26.73	12.1	5.3	3.09	5.2	5.1	9.9	8.	77.	8.	77.	-2.4	15.7
8	10.1	190.9	-0.9	15.83	10.1	5.9	2.84	5.1	5.0	10.0	21.	57.	21.	57.	-2.0	15.6
9	11.5	192.0	-0.7	14.00	11.5	4.8	2.56	5.6	5.5	10.8	7.	73.	7.	73.	-1.1	16.6
10	11.5	192.0	-0.8	18.67	11.5	5.9	4.66	5.1	5.0	9.5	24.	88.	24.	88.	-0.9	14.9
11	12.4	192.6	-0.8	15.81	12.4	5.2	3.59	5.1	5.1	9.5	22.	96.	22.	96.	-9.5	14.4
12	12.6	192.8	-1.0	13.98	12.6	5.1	2.77	5.4	5.4	9.0	23.	64.	23.	64.	-6.7	15.2
13	11.8	192.2	-0.9	14.91	11.8	5.8	2.80	5.4	5.3	9.8	21.	71.	21.	71.	0.9	15.4
14	12.6	192.7	-0.9	15.08	12.6	5.3	2.59	5.6	5.5	9.5	5.	60.	5.	60.	-1.0	15.6
15	11.4	191.9	-0.8	15.74	11.4	4.8	3.74	5.7	5.6	9.4	22.	58.	22.	58.	-4.3	15.3
16	10.7	191.3	-0.7	18.73	10.7	4.9	4.43	5.2	5.1	9.6	56.	95.	56.	95.	-2.3	16.0
17	12.6	192.7	-0.9	14.78	12.6	7.4	1.91	5.4	5.3	9.9	6.	59.	6.	59.	-3.8	17.0
18	11.4	191.9	-0.9	14.99	11.4	6.2	2.89	5.5	5.4	10.5	8.	59.	8.	59.	-3.2	16.2
19	11.7	192.1	-0.8	14.29	11.7	5.2	2.66	5.6	5.6	9.9	23.	57.	23.	57.	4.8	16.9
20	11.4	191.9	-0.8	13.93	11.4	6.8	3.18	5.1	5.0	9.6	24.	60.	24.	60.	-2.4	16.0
21	13.3	193.2	-0.9	14.01	13.3	5.7	2.76	5.7	5.7	9.5	5.	58.	5.	58.	-6.5	16.0
22	12.0	192.4	-0.9	25.33	12.0	7.7	2.28	5.5	5.4	9.5	22.	57.	22.	57.	-1.5	16.1
23	12.7	192.8	-0.8	25.38	12.7	8.0	1.58	5.4	5.3	10.6	7.	79.	7.	79.	-1.2	17.4
24	11.0	191.6	-0.8	14.20	11.0	6.3	2.41	5.2	5.2	9.7	10.	60.	10.	60.	-2.8	16.5
25	11.2	191.7	-0.9	15.78	11.2	5.8	3.33	5.0	5.0	9.5	7.	82.	7.	82.	-1.8	15.6

**LOVELACE SHOCK TUBE TEST**

## OFF AXIS, GRAZING

1 MIN. BETWEEN SHOTS

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TABLE 3-19. MAY 30, ON AXIS, FACE-ON, 1 MIN.

## LOVELACE SHOCK TUBE TEST

30 MAY 79

ON AXIS, FACE-ON

1 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		REFL	TIME	EST	AVE	ADUR		RDUR		EST	TUT		POS
	PSI	DB	PSI	MS	MAX	PSI	MS	MAX	PSI	%S	MS	%S	MS		IMP	MS--	
1	10.7	191.3	-0.8	14.71	10.7	5.3	3.96	5.1	4.9	6.7	26.	84.	84.	--PSI-MS--	-3.4	14.2	
2	11.7	192.1	-0.8	33.34	11.7	5.3	4.27	4.9	4.8	9.1	8.	106.	106.		2.9	15.3	
3	11.1	191.7	-0.7	19.08	11.1	4.5	4.25	4.6	4.5	6.9	22.	140.	140.		1.0	14.2	
4	10.5	191.2	-0.9	15.16	10.5	4.5	4.35	4.7	4.6	7.0	23.	136.	136.		-0.6	14.2	
5	10.0	190.7	-0.8	33.29	10.0	6.1	3.76	4.8	4.6	8.7	27.	105.	105.		-1.0	15.7	
6	12.0	192.3	-1.0	15.06	12.0	4.8	4.46	4.9	4.8	8.6	8.	135.	135.		-0.9	15.1	
7	11.5	192.0	-0.8	14.04	11.5	5.4	3.10	5.0	4.9	6.7	22.	144.	144.		2.2	14.1	
8	11.4	191.9	-0.9	13.73	11.4	4.9	2.85	4.7	4.7	6.4	25.	135.	135.		-0.8	13.9	
9	10.7	191.4	-0.8	13.55	10.7	5.9	2.55	4.9	4.8	6.3	26.	136.	136.		-0.7	14.6	
10	11.6	192.1	-0.8	12.50	11.6	5.3	3.39	4.7	4.7	8.0	8.	140.	140.		-1.6	11.9	
11	11.3	191.8	-0.8	18.43	11.3	5.1	4.16	4.8	4.7	6.8	23.	139.	139.		-2.5	13.5	
12	12.9	193.0	-0.9	18.74	12.9	4.6	3.97	4.9	4.8	6.6	22.	140.	140.		-7.0	13.9	
13	11.9	192.3	-0.8	13.63	11.9	5.1	2.81	4.8	4.8	8.5	21.	137.	137.		-0.8	14.5	
14	10.6	191.3	-0.9	13.59	10.6	5.6	2.53	4.9	4.8	5.5	10.	135.	135.		-1.8	13.6	
15	10.8	191.4	-0.9	18.76	10.8	5.6	4.33	4.7	4.6	7.1	23.	140.	140.		-0.6	14.1	
16	10.1	190.9	-0.9	30.83	10.1	4.8	3.17	5.0	4.9	6.6	58.	91.	91.		0.2	14.3	
17	11.6	192.0	-0.9	13.19	11.6	6.5	1.84	5.0	4.9	5.5	9.	135.	135.		0.0	15.1	
18	10.9	191.5	-0.8	14.94	10.9	4.7	2.89	5.1	5.0	6.7	24.	73.	73.		2.2	14.7	
19	11.8	192.2	-0.8	24.70	11.8	6.6	3.80	5.1	5.0	6.7	26.	68.	68.		-1.4	14.8	
20	11.5	192.0	-0.9	18.87	11.5	5.4	3.14	4.9	4.8	6.7	24.	134.	134.		-0.5	14.3	
21	12.2	192.5	-0.9	13.69	12.2	5.1	2.70	5.1	4.9	6.5	22.	100.	100.		-3.4	14.7	
22	12.2	192.4	-0.9	13.67	12.2	7.4	2.22	5.1	5.0	6.5	20.	86.	86.		-3.9	14.4	
23	11.6	192.1	-0.9	30.35	11.6	6.5	1.54	5.0	4.9	5.6	25.	81.	81.		0.1	15.2	
24	10.5	191.2	-0.8	13.45	10.5	7.3	3.64	5.0	4.8	6.6	9.	92.	92.		-0.2	14.9	
25	9.8	190.6	-0.8	13.81	9.8	4.4	3.94	4.5	4.4	6.8	26.	137.	137.		-0.1	14.2	



TABLE 3-20. MAY 30, ON AXIS, GRAZING, 1 MIN.

## LOVELAKE SHOCK TUBE TEST

30 MAY 79

ON AXIS, GRAZING

1 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		INIT MAX	REFL MAX	TIME REFL	EST MAX	AVE EST	ADUR	RDDR	EST RDDR	TUT IMP	POS IMP
	PSI	DB		MS	PSI										
1	5.1	185.0	-0.9	26.06	5.1	2.6	2.89	3.8	3.7	5.2	59.	149.	-10.4	9.7	
2	4.9	184.5	-0.9	24.62	4.9	3.4	4.19	3.6	3.5	8.4	99.	142.	-5.4	10.8	
3	4.8	184.4	-0.9	25.16	4.8	3.0	4.19	3.4	3.4	6.5	81.	151.	-3.2	10.3	
4	4.8	184.4	-0.9	15.09	4.8	2.9	4.26	3.5	3.5	5.5	99.	139.	-2.5	9.9	
5	4.8	184.4	-1.0	14.61	4.8	3.4	1.58	3.6	3.6	6.1	114.	150.	2.5	10.3	
6	5.0	184.8	-0.9	14.85	5.0	3.3	2.14	3.7	3.7	8.4	92.	136.	0.1	10.9	
7	4.9	184.5	-0.8	13.94	4.9	2.5	4.30	3.6	3.6	7.1	81.	143.	-5.0	10.2	
8	4.8	184.3	-0.9	13.60	4.8	3.3	3.94	3.5	3.5	6.0	80.	146.	-3.4	10.1	
9	4.8	184.4	-0.9	25.58	4.8	3.2	3.92	3.7	3.6	5.9	84.	142.	-1.7	10.4	
10	4.8	184.3	-0.8	15.21	4.8	3.0	4.38	3.6	3.5	6.5	79.	142.	-5.3	9.9	
11	5.0	184.7	-0.8	26.98	5.0	3.1	4.19	3.6	3.6	6.3	81.	145.	-4.7	10.0	
12	5.0	184.7	-0.8	18.80	5.0	3.2	1.68	3.7	3.6	6.3	72.	148.	0.7	10.5	
13	5.2	185.0	-0.9	14.28	5.2	2.8	2.17	3.7	3.7	5.5	84.	144.	-5.8	9.8	
14	5.1	184.9	-0.9	13.86	5.1	4.0	1.74	3.7	3.6	5.1	96.	137.	-2.7	10.0	
15	4.7	184.1	-0.8	14.79	4.7	3.6	4.23	3.4	3.4	8.5	80.	151.	-3.3	11.0	
16	5.1	184.9	-0.9	30.60	5.1	3.8	1.59	3.7	3.6	6.4	80.	147.	-8.5	10.4	
17	5.2	185.1	-1.0	13.75	5.2	4.8	2.06	3.7	3.6	5.2	72.	137.	-5.5	10.9	
18	5.4	185.4	-0.8	32.74	3.4	5.4	17.77	0.1	0.1	0.1	79.	156.	19.1	11.2	
19	5.2	185.0	-1.0	24.97	5.2	3.9	1.73	3.8	3.7	6.1	94.	140.	-3.2	10.7	
20	5.0	184.8	-1.0	25.95	5.0	3.3	4.16	3.6	3.5	6.2	59.	147.	-8.4	10.2	
21	5.4	185.4	-0.9	14.42	5.1	5.4	13.47	0.0	0.0	0.0	20.	156.	9.1	10.8	
22	5.2	185.1	-1.0	25.60	5.2	4.2	1.84	3.8	3.7	5.2	56.	137.	-5.6	10.5	
23	5.2	185.1	-1.0	18.95	5.2	4.8	1.54	3.7	3.6	5.1	58.	148.	0.2	11.0	
24	5.0	184.8	-1.1	32.91	5.0	4.1	1.58	3.7	3.6	6.1	71.	148.	-7.7	10.5	
25	4.9	184.5	-0.9	14.82	4.9	3.7	1.82	3.4	3.4	6.3	91.	155.	-2.7	10.3	

TABLE 3-21. MAY 30, OFF AXIS, FACE-ON, 30 SEC.

## LOVELACE SHOCK TUBE TEST

30 MAY 79

OFF AXIS, FACE-ON

30 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN PSI	TIME MIN		INIT MAX PSI	REFL MAX PSI		TIME REFL MS	EST MAX PSI	AVE EST PSI	ADUR MS	BDUR MS	EST BDUR MS	TOT IMP --PSI-MS--	PUS IMP
	PSI	DB		MS	PSI		MS	PSI								
1	12.1	192.4	-3.2	30.13	6.2	12.1	82.38	0.1	0.0	0.0	0.0	12.	156.	12.3	15.9	
2	12.2	192.5	-1.1	75.76	12.2	6.5	2.19	5.7	5.6	11.2	6.	76.	1.3	17.3		
3	11.7	192.1	-3.3	0.02	10.3	11.7	150.14	0.1	0.0	0.0	0.0	0.	156.	-0.1	0.1	
4	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
5	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
6	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
7	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
8	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
9	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
10	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
11	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
12	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
13	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
14	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
15	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
16	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
17	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
18	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
19	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
20	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
21	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
22	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
23	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
24	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	
25	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	

TABLE 3-22. MAY 30, OFF AXIS, GRAZING, 30 SEC.

## LOVELACE SHOCK TUBE TEST

30 MAY 79

OFF AXIS, GRAZING

30 SEC BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		REFL	TIME		EST	AVE		ADUR	BDUR		EST	TOT	
	PSI	DR	PSI	MS	MS	PSI	MS	PSI		PSI	PSI	MS	MS	MS		IMP	POS
1	5.4	185.5	-1.1	31.77	5.4	2.7	2.77	4.1	4.1	4.1	4.1	5.7	115.	150.	--PSI-MS--		
2	5.8	186.0	-1.1	14.07	5.8	3.3	2.23	4.1	4.1	4.1	4.1	5.3	72.	121.	-3.3	9.4	
3	4.8	184.4	-1.0	16.36	4.8	3.6	3.66	3.3	3.3	3.3	3.3	7.8	110.	129.	-2.9	9.6	
4	4.8	184.4	-1.0	16.36	4.8	3.6	3.66	3.3	3.3	3.3	3.3	7.8	110.	129.	1.8	10.2	
5	5.6	185.7	-1.0	31.17	5.6	3.3	2.51	3.9	3.8	3.8	3.8	7.6	64.	126.	1.8	10.2	
6	5.2	185.0	-1.0	17.81	5.2	2.8	3.51	4.1	4.0	4.0	4.0	7.8	93.	114.	1.2	10.1	
7	5.9	186.1	-2.1	0.00	0.7	5.9	23.61	0.2	0.1	0.1	0.1	0.0	61.	156.	0.5	10.4	
8	5.1	184.9	-1.0	17.14	5.1	3.0	4.02	3.8	3.8	3.8	3.8	7.8	74.	126.	0.9	10.7	
9	5.4	185.3	-1.1	17.46	5.4	2.5	3.49	4.1	4.1	4.1	4.1	7.8	47.	126.	-2.1	9.9	
10	5.5	185.5	-1.0	18.31	5.5	2.4	3.10	4.1	4.1	4.1	4.1	8.1	72.	144.	-3.0	10.2	
11	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.	0.	-1.9	10.3	
12	5.7	185.9	-1.0	30.37	5.7	2.9	3.13	4.0	4.0	4.0	4.0	8.5	73.	121.	0.0	0.0	
13	5.2	185.1	-1.0	17.07	5.2	2.5	3.99	3.7	3.7	3.7	3.7	7.9	112.	153.	-3.6	10.2	
14	5.2	185.0	-1.1	14.39	5.2	3.0	2.35	3.4	3.3	3.3	3.3	5.4	81.	134.	-0.8	9.9	
15	5.2	185.0	-1.0	16.81	5.2	3.2	3.48	3.7	3.7	3.7	3.7	7.8	83.	153.	-6.6	9.0	
16	5.3	185.2	-1.0	14.22	5.3	2.3	3.83	3.6	3.6	3.6	3.6	8.1	97.	117.	1.0	10.5	
17	5.3	185.2	-1.0	14.69	5.3	3.3	2.79	3.7	3.6	3.6	3.6	7.7	83.	152.	2.5	10.5	
18	5.2	185.0	-1.0	19.28	5.2	2.7	4.53	3.8	3.8	3.8	3.8	8.2	112.	130.	0.9	9.9	
19	5.3	185.3	-1.1	25.48	5.3	3.5	2.28	3.8	3.8	3.8	3.8	5.7	91.	130.	-0.5	10.1	
20	5.7	185.8	-1.0	31.09	5.7	3.0	3.55	4.1	4.0	4.0	4.0	7.7	79.	113.	0.8	9.5	
21	4.5	183.9	-1.0	15.57	4.5	2.9	4.05	3.3	3.3	3.3	3.3	8.3	106.	152.	2.4	10.5	
22	4.9	184.6	-1.0	29.44	4.9	3.0	2.71	3.3	3.2	3.2	3.2	7.8	93.	146.	3.1	10.4	
23	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.	0.	1.1	10.2	
24	5.3	185.2	-1.0	18.85	5.3	2.8	4.55	4.0	4.0	4.0	4.0	8.1	81.	151.	0.0	0.0	
25	5.4	185.4	-4.1	95.72	5.0	5.4	90.56	3.7	3.6	3.6	3.6	8.1	135.	151.	-1.0	10.3	
															-2.2	10.2	

TABLE 3-23. MAY 30, ON AXIS, FACE-ON, 30 SEC.

## LOVELACE SHOCK TUBE TEST

30 MAY 79

ON AXIS, FACE-ON

30 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN PSI	TIME		INIT MAX PSI	REFL MAX PSI	TIME REFL MS	EST MAX PSI	AVE EST PSI	ADUR MS	BDUR MS	EST BDUR MS	TOT IMP	POS IMP
	PSI	DB		MIN MS	MAX MS										
1	9.8	190.6	-0.8	13.81	9.8	5.2	3.81	5.1	5.0	6.9	24.	135.	-1.0	14.7	
2	12.5	192.7	-0.8	28.53	12.5	6.3	2.14	5.4	5.4	7.8	5.	84.	-0.6	15.9	
3	12.0	192.3	-0.9	13.51	12.0	5.3	3.24	4.9	4.8	5.6	5.	88.	-2.7	13.7	
4	12.2	192.5	-0.9	12.74	12.2	6.9	4.04	5.9	5.8	9.0	9.	72.	5.2	15.4	
5	9.9	190.6	-0.9	13.21	9.9	4.8	2.46	4.5	4.5	8.5	58.	136.	0.1	15.1	
6	12.2	192.5	-1.6	21.85	12.2	6.7	3.96	5.1	4.9	8.8	6.	58.	1.5	15.5	
7	12.2	192.5	-1.0	13.06	12.2	6.1	1.94	5.1	5.0	7.9	5.	94.	1.3	16.0	
8	12.8	192.9	-0.8	15.01	12.8	8.7	4.22	5.2	5.1	9.1	22.	71.	-1.8	14.9	
9	12.3	192.5	-1.3	69.21	12.3	6.1	3.95	5.1	5.0	8.8	23.	99.	1.1	15.8	
10	10.9	191.5	-0.9	18.26	10.9	4.8	4.21	4.9	4.9	8.6	25.	90.	-2.7	15.0	
11	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.	0.	0.0	0.0	
12	12.6	192.7	-0.8	14.68	12.6	4.8	3.09	5.3	5.2	9.0	23.	136.	0.1	15.3	
13	9.5	190.3	-0.8	18.96	9.5	7.8	4.26	4.5	4.4	9.2	25.	138.	1.3	14.8	
14	10.0	190.8	-0.8	13.95	10.0	5.4	2.28	4.6	4.5	5.5	22.	143.	1.1	13.9	
15	11.1	191.7	-0.8	13.48	11.1	6.1	3.86	4.8	4.7	8.4	59.	97.	2.7	15.4	
16	11.0	191.6	-0.9	13.64	11.0	5.4	4.06	4.9	4.9	8.9	6.	89.	-1.1	15.1	
17	11.7	192.1	-0.8	13.38	11.7	4.5	3.29	4.8	4.7	5.5	9.	106.	-2.9	13.3	
18	9.7	190.5	-0.8	18.86	9.7	6.3	4.64	4.3	4.3	9.1	12.	136.	-3.3	14.8	
19	12.3	192.6	-0.9	11.96	12.3	6.3	3.21	5.2	5.1	5.8	24.	144.	-2.0	14.1	
20	12.3	192.6	-0.7	33.06	12.3	4.4	4.19	5.1	5.0	8.0	5.	71.	5.0	15.3	
21	12.0	192.3	-1.0	18.82	12.0	11.0	4.28	4.8	4.7	8.8	10.	137.	-0.4	15.4	
22	10.8	191.4	-0.8	13.28	10.8	4.2	3.89	4.8	4.7	5.6	6.	79.	0.9	13.6	
23	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.	0.	0.0	0.0	
24	11.7	192.1	-0.9	18.97	11.7	5.3	4.21	4.9	4.8	8.7	28.	95.	4.2	15.2	
25	11.3	191.8	-1.4	126.74	11.3	8.9	4.18	5.2	5.1	8.9	61.	128.	0.8	15.3	

TABLE 3-24. MAY 30, ON AXIS, GRAZING, 30 SEC.

## LOVELACE SHOCK TUBE TEST

30 MAY 79

ON AXIS, GRAZING

30 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		REFL. MAX	REFL. MAX	EST. MAX	AVE	ADUR		HOUR	EST. ADUR	FOT		PDS
	PSI	DR	PSI	MS	MS	PSI	PSI	PSI	PSI	MS	MS	MS	MS	IMP	IMP	MS--
1	5.4	185.3	-1.0	25.56	3.89	2.8	3.7	3.6	3.6	8.3	82.	144.	144.	-8.7	10.9	
2	5.8	185.9	-0.9	28.77	3.06	3.8	4.1	4.0	4.0	5.2	113.	151.	151.	23.1	10.4	
3	5.1	184.9	-1.0	14.08	3.92	2.9	3.7	3.7	3.7	8.1	116.	153.	153.	27.2	10.8	
4	5.4	185.4	-0.9	13.59	3.98	4.0	4.1	4.1	4.1	7.6	114.	155.	155.	22.5	10.5	
5	4.5	183.8	-0.9	13.17	4.04	2.8	3.4	3.4	3.4	5.2	123.	154.	154.	22.9	9.9	
6	5.3	185.3	-1.3	20.38	3.88	3.4	3.7	3.7	3.7	5.5	153.	153.	153.	24.7	10.1	
7	5.1	184.9	-1.0	12.99	2.94	3.4	3.7	3.6	3.6	5.1	111.	149.	149.	11.2	10.5	
8	5.2	185.1	-0.8	14.96	4.16	4.3	3.9	3.7	3.7	8.6	98.	148.	148.	10.4	10.7	
9	4.8	184.4	-1.0	14.97	3.99	3.3	3.7	3.6	3.6	5.6	119.	154.	154.	12.7	10.1	
10	4.9	184.5	-0.9	18.01	3.95	3.5	3.7	3.6	3.6	8.5	114.	152.	152.	10.6	10.8	
11	0.0	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0	0.0	
12	5.4	185.4	-0.9	14.11	4.10	2.9	3.8	3.7	3.7	8.5	80.	138.	138.	-3.6	10.8	
13	5.1	184.9	-0.8	21.21	4.21	3.7	3.3	3.3	3.3	8.6	115.	153.	153.	18.8	10.7	
14	4.5	183.8	-0.9	14.33	2.33	2.6	3.3	3.3	3.3	5.2	117.	155.	155.	26.3	9.9	
15	5.2	185.0	-0.9	18.73	3.80	3.8	3.5	3.5	3.5	8.1	150.	154.	154.	24.7	10.9	
16	4.8	184.4	-0.9	14.10	4.13	2.9	3.6	3.6	3.6	7.6	140.	153.	153.	36.6	10.7	
17	4.8	184.5	-0.9	13.69	3.91	2.9	3.5	3.5	3.5	5.4	113.	153.	153.	20.2	9.9	
18	4.4	183.7	-0.9	21.29	4.46	3.5	3.2	3.1	3.1	8.9	152.	153.	153.	31.1	10.7	
19	5.5	185.5	-0.9	31.83	3.14	3.8	3.7	3.7	3.7	5.2	107.	125.	125.	16.7	10.2	
20	5.6	185.7	-0.8	14.39	3.88	2.6	3.6	3.6	3.6	8.0	148.	153.	153.	28.6	11.1	
21	5.4	185.4	-1.0	18.64	4.22	4.2	3.6	3.5	3.5	8.6	113.	148.	148.	17.7	11.1	
22	4.7	184.2	-1.1	12.96	3.96	2.5	3.3	3.3	3.3	5.1	113.	156.	156.	-5.7	8.6	
23	0.0	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0	0.0	
24	4.9	184.5	-0.8	18.86	4.28	3.4	3.6	3.6	3.6	8.4	98.	142.	142.	1.4	11.1	
25	6.1	186.4	-2.5	5101.60	91.54	6.1	3.8	3.8	3.8	7.1	141.	155.	155.	28.9	10.4	

TABLE 3-25. JUNE 1, OFF AXIS, FACE-ON, 30 SEC.

## LOVELACE SHOCK TUBE TEST

1 JUN 79

OFF AXIS, FACE-ON

30 SEC BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		REFL	MAX	REFL	TIME	EST	MAX	EST	AVE		ADUR	BDUR		EST	FUT		POS
	PSI	DB	PSI	MS	PSI	PSI	PSI	MS	MS	PSI	PSI	PSI	PSI	PSI	MS	MS	MS	MS	IMP	IMP	MS--
1	12.5	192.7	-1.0	19.64	12.5	4.8	4.8	2.61	5.1	5.0	7.8	9.	138.	138.	7.8	9.	138.	138.	-0.6	14.4	--PSI-MS--
2	10.5	191.1	-1.2	17.19	10.5	4.0	4.0	3.45	4.7	4.6	8.9	27.	141.	141.	8.9	27.	141.	141.	3.1	14.0	
3	12.0	192.4	-1.4	14.86	12.0	4.4	4.4	2.94	4.8	4.8	8.0	15.	145.	145.	8.0	15.	145.	145.	-1.1	13.9	
4	12.9	193.0	-1.2	19.01	12.9	4.1	4.1	4.44	5.2	5.1	8.0	24.	136.	136.	8.0	24.	136.	136.	0.9	14.3	
5	10.5	191.1	-0.9	17.14	10.5	4.0	4.0	3.96	4.2	4.1	8.8	22.	142.	142.	8.8	22.	142.	142.	1.9	13.7	
6	11.1	191.6	-1.1	32.64	11.1	4.2	4.2	2.79	4.5	4.5	8.0	56.	148.	148.	8.0	56.	148.	148.	-5.7	13.6	
7	10.1	190.9	-1.0	19.04	10.1	3.9	3.9	3.68	4.3	4.3	8.1	23.	141.	141.	8.1	23.	141.	141.	-2.7	13.2	
8	11.0	191.6	-1.1	14.66	11.0	4.9	4.9	2.68	5.1	5.0	8.9	21.	153.	153.	8.9	21.	153.	153.	-8.3	14.3	
9	10.4	191.1	-1.2	17.17	10.4	3.7	3.7	3.50	4.6	4.5	8.7	40.	141.	141.	8.7	40.	141.	141.	-0.1	14.2	
10	10.3	191.0	-1.1	14.82	10.3	4.2	4.2	3.03	4.6	4.6	8.0	17.	139.	139.	8.0	17.	139.	139.	-2.5	13.9	
11	0.0	0.0	0.6	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.	0.	0.	0.0	0.	0.	0.	0.0	0.0	
12	11.0	191.6	-1.1	19.05	11.0	4.8	4.8	5.04	4.7	4.6	8.0	24.	148.	148.	8.0	24.	148.	148.	-8.1	13.2	
13	10.9	191.5	-1.3	17.02	10.9	4.8	4.8	3.24	5.1	5.0	8.2	17.	139.	139.	8.2	17.	139.	139.	0.8	14.5	
14	11.3	191.8	-1.1	17.02	11.3	4.2	4.2	3.43	4.8	4.8	8.8	46.	138.	138.	8.8	46.	138.	138.	-2.6	14.3	
15	11.8	192.2	-0.9	14.93	11.8	5.4	5.4	4.24	5.3	5.3	8.8	9.	133.	133.	8.8	9.	133.	133.	1.4	14.7	
16	11.0	191.6	-1.3	17.01	11.0	6.1	6.1	3.68	4.8	4.7	8.1	17.	131.	131.	8.1	17.	131.	131.	1.1	14.6	
17	10.4	191.0	-1.1	14.79	10.4	3.9	3.9	4.54	4.6	4.6	9.0	15.	138.	138.	9.0	15.	138.	138.	-2.2	14.3	
18	11.5	191.9	-1.2	14.83	11.5	4.3	4.3	3.38	4.7	4.7	8.2	17.	139.	139.	8.2	17.	139.	139.	-2.5	13.8	
19	11.3	191.8	-1.0	14.77	11.3	3.2	3.2	3.74	4.8	4.7	8.2	8.	139.	139.	8.2	8.	139.	139.	1.5	14.2	
20	11.6	192.1	-0.8	13.95	11.6	4.2	4.2	2.88	4.9	4.9	8.1	8.	99.	99.	8.1	8.	99.	99.	0.5	14.2	
21	9.9	190.7	-0.9	14.66	9.9	5.5	5.5	2.65	4.8	4.8	8.1	9.	137.	137.	8.1	9.	137.	137.	-0.1	14.9	
22	12.4	192.6	-1.1	13.94	12.4	4.2	4.2	3.09	5.3	5.3	8.1	7.	93.	93.	8.1	7.	93.	93.	-0.3	14.4	
23	11.5	191.9	-1.2	14.78	11.5	4.7	4.7	2.92	5.1	5.1	8.0	32.	144.	144.	8.0	32.	144.	144.	-3.5	14.0	
24	10.9	191.5	-1.1	16.98	10.9	5.8	5.8	3.13	4.9	4.8	8.2	22.	139.	139.	8.2	22.	139.	139.	-4.3	14.0	
25	10.3	191.0	-1.1	17.04	10.3	5.3	5.3	3.13	4.9	4.8	8.2	24.	117.	117.	8.2	24.	117.	117.	3.7	14.3	

TABLE 3-26. JUNE 1, OFF AXIS, GRAZING, 30 SEC.

## LOVELACE SHOCK TUBE TEST

1 JUN 79

OFF AXIS, GRAZING  
30 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		INIT	REFL		TIME	EST		AVG	ADUR		BDUR		EST	FUT		PUS
	PSI	DB	MS	PSI	MS	PSI	MAX	PSI	MS	MAX	PSI	PSI	MS	MS	MS	MS	MS	IMP	IMP	MS--
1	5.4	185.4	-1.2	18.84	5.4	2.9	3.14	4.2	4.1	8.9	116.	150.	-1.2	11.1	--PSI-MS--					
2	5.3	185.1	-1.1	18.79	5.3	2.5	3.45	3.8	3.8	8.9	44.	135.	-2.5	10.8						
3	5.5	185.5	-1.1	15.63	5.5	3.0	2.94	4.0	3.9	6.6	82.	129.	-2.5	10.5						
4	5.8	186.0	-1.1	18.29	5.8	2.8	3.08	4.2	4.2	8.7	73.	128.	-4.1	10.8						
5	4.6	184.0	-1.0	18.52	4.6	2.9	3.93	3.5	3.4	8.6	93.	147.	-5.7	10.5						
6	5.1	184.8	-1.1	13.78	5.1	2.7	2.80	3.9	3.8	5.9	81.	136.	-3.9	9.5						
7	4.7	184.2	-1.2	18.61	4.7	2.5	3.67	3.5	3.5	8.0	80.	136.	-6.3	10.2						
8	5.5	185.6	-1.1	18.36	5.5	2.6	3.24	4.1	4.1	8.5	80.	97.	-5.5	10.6						
9	5.1	185.0	-1.0	18.71	5.1	2.3	3.94	3.9	3.8	8.4	56.	132.	-6.4	10.4						
10	4.9	184.6	-1.1	19.81	4.9	2.6	3.82	3.6	3.5	8.3	92.	148.	-7.2	10.4						
11	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.	0.	0.0	0.0						
12	4.8	184.3	-1.1	18.82	4.8	2.4	4.19	3.7	3.6	9.3	83.	117.	-3.0	10.3						
13	5.1	184.9	-1.2	19.19	5.1	2.9	3.26	3.8	3.8	8.1	92.	137.	-4.5	10.1						
14	4.9	184.5	-1.2	18.61	4.9	2.8	3.75	3.8	3.7	8.6	102.	134.	-5.0	10.4						
15	5.7	185.8	-1.1	18.38	5.7	3.3	4.18	4.4	4.3	8.2	73.	82.	-10.6	10.1						
16	5.1	184.8	-1.1	18.97	5.1	3.4	3.66	3.6	3.6	8.3	73.	136.	-6.5	10.8						
17	5.0	184.8	-1.0	18.59	5.0	2.4	4.51	4.0	3.9	8.6	95.	116.	-3.0	10.4						
18	5.2	185.0	-1.0	19.83	5.2	2.8	3.36	3.7	3.7	8.2	81.	153.	-4.0	10.4						
19	5.1	184.9	-1.0	17.16	5.1	2.2	3.73	3.7	3.7	8.1	73.	143.	-6.6	10.3						
20	5.5	185.5	-1.1	18.63	5.5	2.7	2.90	4.1	4.1	8.1	73.	122.	-3.5	10.3						
21	5.0	184.7	-1.1	19.26	5.0	3.1	2.67	3.8	3.7	8.6	94.	139.	-4.0	11.1						
22	5.8	186.0	-1.0	18.49	5.8	2.6	3.91	4.0	4.0	8.3	81.	128.	-2.6	10.6						
23	5.1	184.9	-1.2	15.33	5.1	2.5	2.94	4.0	3.9	8.1	93.	116.	-2.1	10.2						
24	5.0	184.8	-1.1	14.50	5.0	2.8	3.13	3.8	3.7	8.6	82.	128.	-2.6	10.5						
25	5.5	185.5	-1.1	14.30	5.5	3.0	3.13	3.9	3.9	8.1	55.	118.	-4.5	10.3						

TABLE 3-27. JUNE 1, ON AXIS, FACE-ON, 30 SEC.

## LOVELACE SHOCK TUBE TEST

1 JUN 79

ON AXIS, FACE-ON  
30 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		REFL	MAX	REFL	TIME	EST	AVE	ADUR	NDUR	EST HOUR	TOT POS	
	PSI	DB	PSI	MS	PSI	PSI	PSI	MS	PSI	PSI	PSI	MS	MS	MS	IMP	IMP
1	10.8	191.4	-0.7	14.90	10.8	5.7	3.71	5.6	5.5	6.2	5.5	6.2	24.	76.	2.0	15.1
2	11.8	192.2	-0.8	19.24	10.8	11.8	4.31	4.8	4.7	9.3	4.7	9.3	22.	136.	4.8	15.7
3	11.6	192.0	-0.9	32.51	11.6	8.9	4.05	4.8	4.7	6.1	4.7	6.1	57.	103.	0.2	14.3
4	11.5	192.0	-1.2	2127.61	11.5	5.8	4.09	5.1	5.0	9.0	5.0	9.0	57.	136.	-1.6	16.0
5	11.4	191.9	-1.0	19.26	11.4	10.6	4.35	5.0	4.8	9.2	4.8	9.2	25.	137.	1.7	15.1
6	11.8	192.2	-0.9	13.69	11.8	5.4	3.95	5.0	4.9	6.7	4.9	6.7	22.	135.	-1.3	14.4
7	11.1	191.6	-0.9	15.14	11.1	6.2	4.61	4.9	4.7	8.7	4.7	8.7	24.	101.	-1.5	14.9
8	11.3	191.8	-1.0	14.68	11.3	5.2	4.02	4.8	4.8	8.7	4.8	8.7	23.	140.	-1.5	15.9
9	11.3	191.8	-0.9	18.54	11.3	7.8	4.25	4.8	4.7	5.9	4.7	5.9	7.	153.	-5.1	13.5
10	11.6	192.0	-0.9	31.92	11.6	7.3	4.04	4.9	4.8	6.7	4.8	6.7	23.	138.	-3.0	14.2
11	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0
12	12.1	192.4	-0.9	19.23	12.1	6.2	4.76	4.9	4.8	3.4	4.8	3.4	24.	138.	0.0	12.4
13	13.0	193.0	-0.8	18.81	13.0	11.6	4.02	5.7	5.5	6.4	5.5	6.4	5.	84.	-0.3	14.3
14	11.4	191.9	-0.9	19.02	11.4	4.6	4.06	4.7	4.6	8.1	4.6	8.1	10.	145.	-3.8	14.9
15	9.5	190.3	-0.8	18.84	9.5	5.1	4.43	4.0	3.9	7.1	3.9	7.1	56.	152.	0.0	14.7
16	11.4	191.9	-0.8	13.43	11.4	5.5	4.23	5.3	5.1	8.9	5.1	8.9	24.	81.	0.9	15.9
17	10.4	191.1	-0.9	14.06	10.4	6.4	4.46	4.6	4.5	8.6	4.5	8.6	10.	140.	-2.6	15.2
18	11.3	191.8	-0.9	15.07	11.3	7.2	4.14	5.0	4.9	7.0	4.9	7.0	5.	136.	0.5	14.5
19	11.6	192.1	-0.8	14.87	11.6	11.6	4.18	4.7	4.7	9.1	4.7	9.1	12.	144.	2.0	15.9
20	11.4	191.9	-0.8	30.83	11.4	5.7	3.94	5.0	4.9	6.8	4.9	6.8	5.	92.	-2.4	14.4
21	10.8	191.4	-0.8	18.45	10.8	5.5	3.59	4.6	4.4	6.7	4.4	6.7	57.	97.	4.8	15.4
22	13.5	193.4	-0.8	13.78	13.5	5.2	4.11	5.6	5.5	6.7	5.5	6.7	5.	97.	0.6	14.8
23	13.4	193.3	-0.8	31.84	13.4	6.5	3.91	5.4	5.3	8.6	5.3	8.6	5.	136.	-0.2	15.1
24	10.2	190.9	-0.8	13.81	10.2	9.1	4.10	4.6	4.5	9.0	4.5	9.0	23.	144.	-1.8	15.4
25	10.3	191.0	-2.1	118.31	10.3	5.6	4.04	4.3	4.2	6.9	4.2	6.9	7.	143.	-2.7	14.0



TABLE 3-28. JUNE 1, ON AXIS, GRAZING, 30 SEC.

## LOVELACE SHOCK TUBE TEST

1 JUN 79

ON AXIS, GRAZING

30 SEC BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN	TIME		INIT	REFL	TIME	EST	AVE	ADUR		BDUR		EST	BDJR	TOT	POS
	PSI	DB	PSI	MS	MS	PSI	MAX	REFL	MAX	EST	MS	MS	MS	MS				
1	5.7	185.9	-1.1	14.72	5.7	5.7	3.4	3.91	4.1	4.0	6.2	6.2	66.	137.			1.8	11.1
2	5.4	185.4	-1.0	14.19	5.1	5.1	5.4	4.28	3.7	3.6	6.4	6.4	115.	145.			8.3	10.5
3	5.1	184.9	-1.0	14.99	5.1	4.2	4.2	4.04	3.6	3.6	6.4	6.4	119.	128.			9.1	10.7
4	5.5	185.5	-1.0	14.30	5.5	3.8	3.8	4.11	4.0	4.0	8.4	8.4	115.	116.			15.1	11.7
5	5.2	185.0	-1.0	17.26	5.2	3.5	3.5	4.30	3.7	3.6	7.2	7.2	115.	153.			9.5	10.5
6	5.3	185.2	-1.0	13.84	5.3	3.6	3.6	3.87	3.8	3.7	5.7	5.7	114.	152.			11.7	10.7
7	5.2	185.0	-1.1	17.13	5.1	5.2	5.2	4.62	3.7	3.7	6.3	6.3	113.	151.			6.1	10.3
8	5.1	184.9	-1.0	14.84	5.1	3.9	3.9	3.95	3.7	3.7	6.1	6.1	113.	139.			9.6	10.7
9	4.7	184.2	-1.0	14.17	4.7	3.5	3.5	4.20	3.7	3.7	5.8	5.8	149.	151.			9.4	10.2
10	5.1	184.9	-0.9	14.49	5.1	3.6	3.6	3.99	3.8	3.7	6.0	6.0	115.	154.			13.0	10.4
11	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.			0.0	0.0
12	5.2	185.1	-1.1	17.11	5.2	3.9	3.9	4.68	3.7	3.7	3.7	3.7	115.	153.			1.9	9.6
13	5.9	186.2	-1.0	14.64	5.9	5.4	5.4	3.98	4.1	4.0	6.3	6.3	113.	127.			5.6	10.4
14	5.0	184.7	-0.9	40.10	5.0	3.1	3.1	4.00	3.6	3.5	8.1	8.1	114.	154.			16.2	11.4
15	4.4	183.6	-1.1	19.16	4.4	3.9	3.9	4.33	3.0	3.0	6.6	6.6	145.	151.			14.5	10.5
16	5.7	185.9	-1.0	13.57	5.7	3.3	3.3	3.98	4.0	3.9	6.0	6.0	114.	154.			10.9	10.7
17	4.8	184.4	-1.0	16.78	4.8	3.3	3.3	4.38	3.5	3.5	7.1	7.1	115.	154.			7.1	10.7
18	5.2	185.1	-1.0	21.31	5.2	3.7	3.7	4.08	3.8	3.8	7.2	7.2	115.	155.			8.3	10.7
19	4.8	184.3	-1.0	14.68	4.8	4.5	4.5	4.14	3.5	3.4	6.0	6.0	115.	152.			12.6	10.4
20	5.1	194.9	-1.0	0.13	1.3	5.1	5.1	21.75	0.4	0.3	0.0	0.0	115.	156.			11.3	10.9
21	4.8	184.4	-1.0	13.68	4.8	3.1	3.1	4.04	3.5	3.5	6.4	6.4	120.	152.			17.8	11.3
22	5.4	185.5	-0.9	13.75	5.4	3.7	3.7	3.96	4.1	4.0	6.9	6.9	117.	153.			24.4	11.0
23	5.7	185.0	-1.0	13.78	5.7	3.7	3.7	3.85	4.0	3.9	7.2	7.2	114.	150.			7.2	10.7
24	5.0	184.7	-0.9	13.85	5.0	3.7	3.7	4.04	3.4	3.4	7.2	7.2	116.	150.			8.0	10.8
25	4.4	183.7	-0.9	17.13	4.4	4.1	4.1	3.98	3.3	3.3	8.4	8.4	115.	152.			18.2	11.2

TABLE 3-29. JUNE 4, OFF AXIS, FACE-ON, 1 MIN.

## LOVELACE SHOCK TUBE TEST

4 JUN 79

OFF AXIS, FACE-ON  
1 MIN BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		REFL	TIME	EST		AVE	ADUR		HOUR	EST	FOT	POS
	PSI	OR	PSI	MS	PSI	MAX	MS	PSI	MAX	PSI	MS	MS		MS	IMP	IMP
1	11.0	191.6	-0.9	25.31	11.0	7.2	2.14	5.6	5.5	5.5	9.5	24.	58.	58.	2.5	16.7
2	13.4	193.3	-0.8	14.78	13.4	8.6	2.11	5.6	5.6	5.6	9.8	5.	60.	60.	1.5	16.8
3	12.9	192.9	-0.8	18.63	12.9	6.3	2.63	5.4	5.3	5.3	9.8	22.	71.	71.	-2.5	16.6
4	11.6	192.0	-0.8	14.75	11.6	6.3	2.39	5.5	5.4	5.4	10.7	7.	58.	58.	2.6	17.5
5	11.9	192.2	-0.8	25.61	11.9	5.9	2.56	5.5	5.4	5.4	9.7	7.	73.	73.	-1.7	15.9
6	12.2	192.5	-0.8	25.91	12.2	7.4	2.12	5.6	5.5	5.5	9.0	5.	67.	67.	0.6	16.4
7	11.2	191.7	-0.8	26.12	11.2	8.6	1.81	5.4	5.4	5.4	9.7	7.	74.	74.	0.5	16.7
8	11.1	191.7	-0.9	25.76	11.1	7.6	2.03	5.6	5.6	5.6	10.8	7.	61.	61.	-5.6	17.4
9	13.1	193.1	-0.7	33.01	13.1	7.6	2.19	5.4	5.3	5.3	10.3	7.	140.	140.	-0.6	17.2
10	12.4	192.6	-0.8	24.99	12.4	9.5	1.58	5.8	5.7	5.7	10.5	7.	66.	66.	11.9	18.4
11	12.7	192.8	-0.8	139.98	12.7	8.1	2.29	5.6	5.5	5.5	9.5	7.	78.	78.	3.3	17.0
12	12.1	192.4	-0.8	25.08	12.1	9.0	1.78	5.8	5.8	5.8	10.3	5.	73.	73.	6.4	17.6
13	12.4	192.6	-0.8	15.16	12.4	5.4	2.41	5.3	5.2	5.2	9.3	7.	73.	73.	-3.1	15.8
14	11.7	192.1	-0.8	13.65	11.7	7.0	1.96	5.3	5.3	5.3	9.2	7.	72.	72.	-2.2	16.9
15	11.7	192.1	-0.9	25.03	11.7	5.9	2.62	5.3	5.3	5.3	10.7	7.	73.	73.	-2.3	16.7
16	11.6	192.0	-0.9	14.46	11.6	8.0	2.17	5.3	5.3	5.3	9.5	7.	81.	81.	-2.3	16.5
17	11.5	192.0	-0.8	25.56	11.5	5.3	3.15	5.2	5.1	5.1	9.6	23.	73.	73.	-4.8	15.3
18	12.6	192.7	-0.8	25.52	12.6	6.4	2.25	5.4	5.4	5.4	9.5	7.	74.	74.	-2.2	16.9
19	12.5	192.7	-0.8	14.07	12.5	5.5	2.68	5.5	5.5	5.5	10.2	21.	66.	66.	-1.9	16.5
20	11.9	192.2	-0.8	15.55	11.9	5.9	4.67	5.4	5.4	5.4	9.5	22.	73.	73.	-1.2	15.4
21	13.1	193.1	-0.8	130.38	13.1	5.3	2.95	5.6	5.6	5.6	9.6	55.	73.	73.	4.6	16.8
22	12.3	192.5	-0.8	14.46	12.3	5.7	4.54	5.3	5.3	5.3	9.5	7.	81.	81.	-2.0	15.7
23	11.9	192.2	-0.7	39.93	11.9	4.9	3.33	5.4	5.4	5.4	9.6	23.	64.	64.	-0.9	15.3
24	11.4	191.9	-0.9	14.68	11.4	5.0	3.51	5.5	5.4	5.4	10.0	8.	58.	58.	0.7	15.5
25	12.5	192.7	-0.8	15.55	12.5	5.8	2.63	5.5	5.4	5.4	9.5	22.	83.	83.	1.5	16.2

TABLE 3-30. JUNE 4, OFF AXIS, GRAZING, 1 MIN.

## LOVELACE SHOCK TUBE TEST

4 JUN 79

OFF AXIS, GRAZING

1 MIN BETWEEN SHOTS

SHOT	MAXIMUM PRESSURE		MIN PSI	TIME MIN MS	INIT MAX PSI		REFL MAX PSI	TIME REFL MS	EST MAX PSI		AVE EST PSI	ADUR MS	BDUR MS	EST IMP		PDS
	PSI	DB			PSI	PSI			PSI	PSI				MS	MS	
1	5.8	186.1	-1.2	29.33	5.8	3.5	2.28	4.0	4.0	4.0	5.3	71.	127.	-6.8	9.4	---
2	5.7	185.9	-1.2	25.63	5.7	3.5	2.14	4.1	4.1	4.1	5.3	74.	116.	-4.3	9.5	---
3	5.3	185.3	-1.1	31.69	5.3	3.1	2.65	3.9	3.9	3.9	7.9	74.	134.	-3.4	10.4	---
4	5.1	185.0	-1.2	25.52	5.1	3.3	2.41	4.1	4.0	4.0	7.8	74.	98.	-2.3	10.6	---
5	5.6	185.7	-1.0	14.34	5.6	3.2	2.58	4.0	3.9	3.9	7.9	82.	134.	-4.3	10.1	---
6	5.4	185.4	-1.1	31.48	5.4	3.4	2.16	4.0	4.0	4.0	7.8	82.	118.	1.2	10.4	---
7	5.5	185.6	-1.0	32.39	5.5	3.8	1.83	4.0	3.9	3.9	8.4	69.	116.	-0.6	10.9	---
8	5.2	185.1	-1.2	29.96	5.2	3.4	2.06	4.0	4.0	4.0	5.3	57.	136.	-13.6	9.5	---
9	5.2	185.0	-1.0	29.81	5.2	3.6	2.21	3.9	3.8	3.8	5.5	86.	116.	-2.0	9.5	---
10	5.2	185.0	-1.1	25.31	5.2	4.2	1.61	4.1	4.1	4.1	7.8	98.	128.	-1.7	10.9	---
11	5.4	185.4	-1.1	30.14	5.4	4.0	2.31	4.0	3.9	3.9	7.9	74.	116.	0.0	10.6	---
12	5.4	185.5	-1.0	25.44	5.4	4.5	1.81	4.1	4.1	4.1	5.2	95.	127.	-1.6	9.8	---
13	5.1	184.8	-1.0	18.53	5.1	3.0	2.43	3.8	3.8	3.8	6.6	66.	128.	-2.8	9.6	---
14	5.5	185.5	-1.0	25.16	5.5	4.2	1.98	3.9	3.9	3.9	8.1	81.	116.	1.3	10.8	---
15	5.2	185.1	-1.0	25.38	5.2	2.9	2.64	3.8	3.8	3.8	8.4	73.	118.	-1.6	10.5	---
16	5.2	185.0	-1.0	25.56	5.2	4.0	2.20	3.8	3.8	3.8	7.7	74.	135.	-1.6	10.4	---
17	5.1	185.0	-1.0	26.59	5.1	2.7	3.17	3.8	3.8	3.8	8.5	80.	117.	-2.2	10.2	---
18	5.3	185.1	-1.2	25.40	5.3	3.3	2.28	4.0	3.9	3.9	7.7	94.	115.	-2.7	10.6	---
19	5.4	185.4	-1.0	18.39	5.4	2.9	3.08	3.9	3.9	3.9	7.8	74.	145.	-3.7	10.1	---
20	5.2	185.0	-1.0	15.86	5.2	2.5	3.55	4.0	4.0	4.0	8.7	55.	154.	-4.4	10.0	---
21	5.7	185.8	-1.1	15.59	5.7	2.7	2.97	4.0	4.0	4.0	9.2	77.	115.	-3.2	10.6	---
22	4.9	184.6	-1.1	20.22	4.9	2.5	2.92	3.8	3.8	3.8	7.9	115.	137.	-2.0	10.2	---
23	5.4	185.3	-1.0	26.29	5.4	2.2	3.34	4.0	3.9	3.9	7.7	54.	84.	-7.8	9.5	---
24	5.4	185.3	-1.0	15.78	5.4	2.5	3.51	4.1	4.0	4.0	8.3	81.	115.	-2.7	9.9	---
25	5.0	184.8	-1.1	31.96	5.0	3.1	2.64	4.0	3.9	3.9	7.8	96.	149.	-2.9	10.3	---

TABLE 3-31. JUNE 4, ON AXIS, FACE-ON, 1 MIN.

## LOVELACE SHOCK TUBE TEST

4 JUN 79

ON AXIS, FACE-ON

1 MIN BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		REFL	TIME	EST	AVE	ADUR		BDUR	EST	TOT		PUS
	PSI	DB	PSI	MIN	MS	MAX	MS	PSI	PSI	MS	MS	MS	MS	IMP	PSI-MS--	IMP
1	12.3	192.5	-0.9	128.89	12.3	6.3	2.09	4.9	4.8	5.4	5.4	24.	147.	-3.0	14.1	14.1
2	12.3	192.6	-0.9	18.77	12.3	7.1	2.04	5.1	5.0	6.1	6.1	26.	108.	3.0	14.8	14.8
3	12.2	192.5	-0.8	13.55	12.2	5.8	3.88	5.0	4.0	5.0	5.0	21.	153.	1.2	14.5	14.5
4	12.0	192.3	-0.8	14.59	12.0	5.7	3.66	5.1	4.9	5.5	5.5	8.	146.	-5.3	14.3	14.3
5	11.8	192.2	-0.9	31.44	11.8	5.8	2.58	5.0	4.9	6.1	6.1	21.	140.	-5.2	14.0	14.0
6	12.2	192.5	-0.9	13.38	12.2	6.6	2.06	5.2	5.1	8.5	8.5	24.	128.	10.1	16.2	16.2
7	11.7	192.1	-0.8	13.54	11.7	7.2	1.77	5.0	4.9	6.3	6.3	10.	139.	1.9	14.8	14.8
8	12.8	192.9	-0.8	18.89	12.8	7.1	2.06	5.2	5.1	6.1	6.1	8.	94.	6.0	15.3	15.3
9	11.9	192.3	-0.9	33.45	11.9	6.4	2.11	5.2	5.0	8.1	8.1	9.	107.	4.2	16.4	16.4
10	10.9	191.5	-0.8	31.06	10.9	5.5	1.52	5.2	5.1	6.1	6.1	26.	82.	5.9	15.6	15.6
11	12.8	192.9	-0.8	13.37	12.8	6.2	2.25	5.2	5.0	6.7	6.7	9.	137.	2.2	15.1	15.1
12	11.5	192.0	-0.9	13.38	11.5	7.6	1.71	5.4	5.3	5.4	5.4	24.	91.	0.0	14.8	14.8
13	12.7	192.8	-0.9	13.53	12.7	4.6	2.42	5.1	5.1	6.4	6.4	5.	148.	-9.6	13.8	13.8
14	11.4	191.9	-1.9	29.06	11.4	7.1	1.89	5.3	5.2	6.2	6.2	58.	133.	3.7	15.3	15.3
15	11.8	192.2	-0.8	17.98	11.8	5.5	3.81	4.9	4.7	6.2	6.2	8.	135.	2.1	14.4	14.4
16	11.3	191.8	-0.9	13.52	11.3	5.8	2.13	4.7	4.6	5.7	5.7	20.	138.	-2.0	14.3	14.3
17	11.2	191.7	-0.9	18.71	11.2	5.5	3.14	5.0	4.9	6.6	6.6	23.	140.	0.5	13.8	13.8
18	11.1	191.7	-1.1	0.00	11.1	5.7	2.26	5.3	5.2	6.7	6.7	23.	99.	-2.6	15.0	15.0
19	12.3	192.5	-0.9	18.83	12.3	6.3	3.76	5.3	5.2	6.6	6.6	8.	143.	-1.4	14.5	14.5
20	12.7	192.8	-0.7	18.34	12.7	5.2	4.43	4.9	4.9	3.5	3.5	10.	142.	1.5	12.9	12.9
21	12.8	192.9	-0.9	18.60	12.8	4.8	3.90	5.3	5.2	6.2	6.2	23.	130.	-3.1	14.0	14.0
22	11.3	191.8	-0.7	40.70	11.3	4.6	4.00	4.9	4.9	5.9	5.9	22.	144.	-0.8	13.5	13.5
23	12.2	192.5	-0.8	33.40	12.2	5.2	4.56	5.2	5.1	8.5	8.5	8.	135.	4.0	14.7	14.7
24	11.3	191.8	-0.8	15.06	11.3	5.4	4.51	4.9	4.8	8.7	8.7	57.	97.	0.6	14.7	14.7
25	11.9	192.3	-0.9	14.79	11.9	5.4	2.65	5.1	5.0	8.5	8.5	23.	107.	9.3	15.4	15.4

TABLE 3-32. JUNE 4, ON AXIS, GRAZING, 1 MIN.

## LOVEFACE SHOCK TUBE TEST

4 JUN 79

ON AXIS, GRAZING

1 MIN BETWEEN SHOTS

SHOT	MAXIMUM		MIN	TIME		REFL	MAX	REFL	TIME	EST	AVE	ADUR	BDUR	EST	BDUR	TDT	PNS
	PSI	DB	PSI	MS	MS	PSI	PSI	MS	MS	PSI	PSI	MS	MS	MS	MS	IMP	IMP
1	5.1	184.9	-1.0	25.55	5.1	3.4	3.4	2.12	3.7	3.6	3.6	5.3	81.	147.	147.	-10.6	10.2
2	5.1	185.0	-0.9	24.94	5.1	3.5	3.5	2.06	3.8	3.8	3.8	5.3	66.	131.	131.	-3.7	10.4
3	5.3	185.2	-0.9	31.31	5.3	3.2	3.2	3.88	3.7	3.6	3.6	7.0	84.	141.	141.	-6.1	10.6
4	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.	0.	0.	0.0	0.0
5	5.1	184.8	-0.9	31.54	5.1	3.5	3.5	3.89	3.7	3.7	3.7	5.3	79.	149.	149.	-7.2	9.9
6	4.9	184.5	-1.0	13.56	4.9	3.6	3.6	2.08	3.8	3.8	3.8	5.3	81.	136.	136.	-1.5	10.3
7	5.5	185.6	-1.0	31.38	5.5	3.7	3.7	3.24	3.8	3.7	3.7	5.2	57.	151.	151.	-3.2	10.5
8	5.2	185.0	-0.9	25.01	5.2	3.3	3.3	2.13	3.9	3.8	3.8	8.0	82.	140.	140.	-3.0	11.6
9	5.2	185.0	-1.0	24.98	5.2	3.5	3.5	2.13	3.7	3.7	3.7	8.0	114.	140.	140.	-2.1	11.3
10	5.4	185.4	-0.9	25.63	5.4	4.3	4.3	1.52	3.8	3.7	3.7	5.2	65.	139.	139.	-4.7	10.7
11	5.3	185.3	-0.9	13.49	5.3	3.0	3.0	2.27	3.8	3.7	3.7	5.3	81.	139.	139.	-8.0	10.2
12	5.4	185.4	-0.9	30.31	5.4	4.1	4.1	1.74	3.9	3.8	3.8	5.2	70.	128.	128.	-3.5	10.5
13	5.4	185.4	-0.9	13.54	5.4	2.6	2.6	2.44	3.8	3.8	3.8	6.8	66.	130.	130.	-3.8	10.2
14	5.2	185.0	-0.9	13.66	5.2	3.3	3.3	1.91	3.8	3.8	3.8	5.2	75.	143.	143.	-3.0	10.6
15	4.7	184.3	-0.9	33.31	4.7	2.8	2.8	3.86	3.6	3.5	3.5	6.4	94.	139.	139.	-1.4	10.4
16	4.9	184.6	-1.0	25.31	4.9	3.5	3.5	2.15	3.6	3.5	3.5	5.2	73.	148.	148.	-3.3	10.4
17	5.1	184.9	-0.9	33.34	5.1	3.2	3.2	4.25	3.6	3.6	3.6	8.5	80.	141.	141.	-1.7	10.9
18	5.3	185.2	-0.9	25.55	5.3	3.1	3.1	2.28	3.9	3.8	3.8	5.5	65.	105.	105.	-3.7	10.4
19	5.5	185.5	-0.9	25.17	1.7	5.5	5.5	6.44	0.0	-0.2	-0.2	0.0	66.	156.	156.	-7.8	10.6
20	5.0	184.8	-0.8	15.30	5.0	3.5	3.5	4.35	3.7	3.7	3.7	8.5	72.	139.	139.	-4.0	10.7
21	5.4	185.4	-1.0	14.64	5.4	3.1	3.1	3.89	3.9	3.8	3.8	5.5	59.	134.	134.	-4.7	9.9
22	5.1	184.8	-0.9	13.94	5.1	3.0	3.0	4.24	3.7	3.6	3.6	7.1	99.	140.	140.	-1.9	10.1
23	5.4	185.3	-0.9	25.49	5.4	3.3	3.3	4.49	3.8	3.8	3.8	6.4	57.	152.	152.	-6.2	9.7
24	5.4	185.3	-0.8	31.38	5.4	3.6	3.6	4.44	3.7	3.6	3.6	8.6	82.	141.	141.	-3.7	10.6
25	5.5	185.5	-1.4	56.39	5.5	3.1	3.1	3.99	3.7	3.7	3.7	6.7	106.	140.	140.	-3.3	10.3

## SECTION 4 SUMMARY DATA

### 4-1 PRESENTATION OF DATA

In this section, the data supporting the conclusion drawn in Section 1 are presented. Following the text of this section are nine tables summarizing the May shock tube test and its relation to other tests of the shock tube and howitzer.

Tables 2-4 through 2-6 list the peak recorded pressures, estimated peak pressures (see Section 3) and positive impulses for each shot of the May test. (The positive impulse of a pressure time history is the pressure impulse from pulse onset to the point in time when the pressure returns to the ambient level for the first time.) Also included in these three tables are some summary statistics.

Table 2-7 gives the the ratios of the standard deviation in peak pressure to the average peak recorded pressure expressed in percentages. Table 2-8 gives similar information on the positive impulses.

Tables 2-9 through 2-11 contain correlation information. The correlation coefficients between various pressure time histories 50ms after pulse onset are presented. In addition, the minimum correlation coefficient occurring during this time interval is presented. Volume III of this series of reports gives an explanation of this parameter (see References).

The last table, Table 2-12, presents the standard deviation, normalized skewness and normalized kurtosis of the correlated pressure time histories. Graphs of the pressure time histories of the shots analyzed in this Section can be found in Section 5.

### 4-2 CONCLUSIONS

The replacement of the second coil of primercord improved the shot-to-shot reproducibility of the shock tube. This is supported in Tables 2-7, 2-8 and 2-10. Table 2-7 shows that the standard deviation in peak pressures on a given day

TABLE 2-4. RECORDED MAXIMUM

LIVELACE SHOCK TUNE TEST

ON AXIS. FACE-IN

RECORDED MAXIMUM (PSI)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	11.6	10.8	11.9	11.8	10.7	9.8	10.8	12.3
2	11.4	10.3	12.3	11.6	11.7	12.5	11.8	12.3
3	11.9	10.9	11.9	9.7	11.1	12.0	11.6	12.2
4	10.2	11.3	13.2	10.5	10.5	12.2	11.5	12.0
5	12.1	11.2	12.9	12.8	10.0	9.9	11.4	11.8
6	10.9	11.1	12.4	11.0	12.0	12.2	11.8	12.2
7	10.8	10.8	12.4	11.9	11.5	12.2	11.1	11.7
8	11.4		11.9	11.8	11.4	12.8	11.3	12.8
9	14.7	11.0	12.2	10.9	10.7	12.3	11.3	11.9
10	10.5	10.8	11.8	12.6	11.6	10.9	11.6	10.9
11	10.9	10.5	13.3	8.8	11.3			12.8
12	10.9	10.5	12.6	10.6	12.9	12.6	12.1	11.5
13	11.4	12.1	12.6	11.9	11.9	9.5	13.0	12.7
14	12.8	11.8	12.7	14.1	10.6	10.0	11.4	11.4
15	11.2	11.4	11.9	10.4	10.8	11.1	9.5	11.8
16	11.0	11.0	13.4	11.4	10.1	11.0	11.4	11.3
17	10.7	12.4	11.7	11.9	11.6	11.7	10.4	11.2
18	12.1	11.1	12.3	11.1	10.9	9.7	11.3	11.1
19	13.0	11.9	12.2	11.3	11.8	12.3	11.6	12.3
20	12.9	11.5	13.1	10.7	11.5	12.3	11.4	12.7
21	10.6	11.7	12.0	11.6	12.2	12.0	10.8	12.8
22	13.7	11.7	12.0	11.8	12.2	10.8	13.5	11.3
23	11.9	11.3	12.8	12.8	11.6		13.4	12.2
24	14.5	11.5	11.7	11.3	10.5	11.7	10.2	11.3
25	11.0	12.5	11.0	12.6	9.8	11.3	10.3	11.9

OVERPRESSURE SUMMARY (PSI)

DAILY AVERAGE	11.9	11.3	12.3	11.5	11.3	11.4	11.4	11.9
STD. DEV.	1.25	0.57	0.58	1.09	0.76	1.04	0.93	0.58
DAILY VARIANCE	1.56	0.33	0.34	1.19	0.58	1.08	0.87	0.34
GRAND AVERAGE AND VARIANCE	11.6 0.89							
VARIANCE BETWEEN GROUPS	3.69							
VARIANCE WITHIN GROUPS	0.79							

DAILY MAX. AND SHOT NO.	14.7	9	12.5	25	13.4	16	14.1	14	12.9	12	12.8	8	13.5	22	12.9	21
DAILY MIN. AND SHOT NO.	10.2	4	10.3	2	11.0	25	8.8	11	9.8	25	9.5	13	9.5	15	10.9	10

TABLE 2-4 (Cont.). ESTIMATED MAXIMUM

LOVELACE SHOCK TUBE TEST

ON AXIS, FACE-IN

ESTIMATED MAXIMUM (PSI)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	4.9	5.0	4.9	4.8	5.1	5.1	5.6	4.9
2	4.9	5.2	5.4	5.5	4.9	5.4	4.9	5.1
3	5.3	5.1	5.2	4.1	4.6	4.9	4.8	5.0
4	4.9	5.0	5.3	4.8	4.7	5.9	5.1	5.1
5	5.1	5.1	5.5	5.5	4.8	4.5	5.0	5.0
6	5.3	4.7	5.2	5.1	4.9	5.1	5.0	5.2
7	5.1	4.9	5.5	5.0	5.0	5.1	4.9	5.0
8	5.1		5.3	4.8	4.7	5.2	4.8	5.2
9	5.6	5.0	5.1	4.7	4.9	5.1	4.8	5.2
10	5.0	5.1	5.2	5.5	4.7	4.9	4.9	5.2
11	5.0	5.1	5.6	4.2	4.8	5.3	4.9	5.4
12	5.4	4.8	5.4	4.5	4.9	4.5	5.7	5.1
13	5.4	5.0	5.1	5.1	4.8	4.6	4.7	5.3
14	4.8	4.7	5.4	5.8	4.9	4.7	4.7	4.9
15	5.2	5.0	5.1	4.7	4.7	4.8	4.0	4.9
16	5.0	5.1	5.6	5.5	5.0	4.9	5.3	4.7
17	5.4	5.2	5.1	5.3	5.0	4.8	4.6	5.0
18	5.5	5.3	4.9	4.9	5.1	4.3	5.0	5.3
19	5.1	4.9	5.0	4.9	5.1	5.2	4.7	5.3
20	5.6	5.1	5.3	4.7	4.9	5.1	5.0	4.9
21	5.0	4.8	5.0	5.6	5.1	4.8	4.6	5.3
22	5.4	5.4	5.2	5.4	5.1	4.8	5.6	4.9
23	5.2	5.0	5.2	5.2	5.0	5.4	5.4	5.2
24	5.1	4.8	4.9	4.6	5.0	4.9	4.6	4.9
25	5.6	5.3	4.8	5.0	4.5	5.2	4.3	5.1

ESTIMATED OVERPRESSURE SUMMARY (PSI)

DAILY AVERAGE	5.2	5.0	5.2	5.0	4.9	5.0	5.1
STD. DEV.	0.24	0.18	0.22	0.44	0.16	0.34	0.17
DAILY VARIANCE	0.06	0.03	0.05	0.19	0.02	0.12	0.03
GRAND AVERAGE AND VARIANCE	5.0 0.09						
VARIANCE BETWEEN GROUPS	0.16						
VARIANCE WITHIN GROUPS	0.08						

DAILY MAX. AND SHOT NO.	5.6 25	5.4 22	5.6 11	5.8 14	5.1 18	5.9 4	5.7 13	5.4 12
DAILY MIN. AND SHOT NO.	4.8 14	4.7 14	4.8 25	4.1 3	4.5 25	4.3 18	4.0 15	3.7 16



TABLE 2-4 (Cont.). POSITIVE IMPULSE

LOVELACE SHUCK TUNE TEST

ON AXIS. FACE-IN

POSITIVE IMPULSE (PSI-MS)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	17.3	16.6	15.0	14.7	14.2	14.7	15.1	14.1
2	17.0	17.0	16.1	14.6	15.3	15.9	15.7	14.8
3	17.5	17.0	14.8	14.5	14.2	13.7	14.3	14.5
4	16.3	16.6	14.6	14.5	14.2	15.4	16.0	14.3
5	17.3	16.9	16.2	15.2	15.7	15.1	15.1	14.0
6	17.5	16.0	15.1	14.7	15.1	15.5	14.3	16.2
7	17.0	16.2	15.7	15.1	14.1	16.0	14.9	14.8
8	16.8		15.0	14.1	13.8	14.9	15.9	15.3
9	17.3	17.3	14.6	15.3	14.6	15.8	13.6	16.4
10	17.1	16.9	14.9	14.6	13.9	15.0	14.2	15.6
11	17.3	17.3	15.9	15.7	13.5		12.4	15.1
12	16.0	16.3	14.6	14.8	13.9	15.3	14.3	14.7
13	17.0	16.7	14.9	15.1	14.5	14.8	14.3	13.8
14	16.7	17.3	15.1	14.8	13.6	13.9	14.9	15.3
15	16.7	17.2	16.0	15.4	14.0	15.4	14.7	14.4
16	17.0	15.7	15.5	14.6	14.3	15.1	15.9	14.3
17	17.3	17.4	15.6	15.5	15.1	13.3	15.2	13.8
18	17.5	17.0	14.4	14.9	14.7	14.8	14.5	15.0
19	17.0	16.9	15.4	15.5	14.8	14.1	15.9	14.5
20	16.3	16.9	15.0	15.2	14.3	15.3	14.4	12.9
21	17.3	17.6	14.9	16.7	14.7	15.4	15.4	14.0
22	17.0	17.5	14.6	15.1	14.4	13.6	14.8	13.5
23	17.3	16.1	14.0	15.0	15.2		15.1	14.7
24	17.1	17.3	15.5	15.0	14.9	15.2	15.4	14.7
25	17.4	16.2	15.1	14.8	14.2	15.3	14.0	15.8

POSITIVE IMPULSE SUMMARY (PSI-MS)

DAILY AVERAGE	17.2	16.9	15.1	15.0	14.4	14.9	14.8	14.7
STD. DEV.	0.44	0.57	0.56	0.50	0.56	0.74	0.84	0.82
DAILY VARIANCE	0.19	0.33	0.32	0.25	0.31	0.55	0.71	0.68

GRAND AVERAGE AND VARIANCE 15.4 1.39

VARIANCE BETWEEN GROUPS 27.48

VARIANCE WITHIN GROUPS 0.41

DAILY MAX. AND SHOT NO. 18.3 20 18.2 25 16.2 5 16.7 21 15.7 5 16.0 7 16.4 9  
DAILY MIN. AND SHOT NO. 16.1 4 15.7 16 14.0 23 14.3 8 13.5 11 12.4 12 12.4 20

TABLE 2-4. (Cont.). RECORDED MAXIMUM

## LOVELACE SHOCK TUBE TEST

## ON AXIS, GRAZING

## RECORDED MAXIMUM (PSI)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	0.0	5.2	5.5	5.1	5.1	5.4	5.7	5.1
2	0.0	5.4	5.7	5.9	4.9	5.4	5.4	5.1
3	0.0	5.2	5.9	4.3	4.8	5.1	5.1	5.3
4	0.0	5.3	5.8	5.1	4.8	5.4	5.5	5.0
5	0.0	5.2	5.6	6.6	4.8	4.5	5.2	5.1
6	0.0	4.4	5.6	5.1	5.0	5.3	5.3	4.9
7	0.0	5.3	5.6	5.3	4.9	5.1	5.2	5.5
8	0.0		5.6	4.7	4.8	5.2	5.1	5.2
9	0.0		5.6	4.5	4.8	4.8	4.7	5.2
10	0.0	5.3	5.4	5.4	4.8	4.9	5.1	5.4
11	0.0	5.5	5.3	4.5	5.0	5.4	5.2	5.3
12	0.0	4.9	5.7	4.5	5.0	5.4	5.2	5.4
13	0.0	5.2	5.8	5.3	5.2	5.1	5.9	5.4
14	0.0	5.0	5.3	5.7	5.1	4.5	5.0	5.2
15	0.0	5.0	5.6	5.0	4.7	5.2	4.4	4.7
16	0.0	5.3	5.3	5.4	5.1	4.8	5.7	4.9
17	0.0	5.5	5.7	5.4	5.2	4.8	4.8	5.1
18	0.0	5.6	5.2	5.0	5.4	4.4	5.2	5.3
19	0.0	5.3	5.4	4.4	5.2	5.5	4.8	5.5
20	0.0	5.2	5.4	5.0	5.0	5.6	5.1	5.0
21	0.0	5.3	5.6	5.7	5.4	5.4	4.8	5.4
22	0.0	5.5	5.3	5.1	5.2	4.7	5.4	5.1
23	0.0	5.5	5.6	5.5	5.2		5.7	5.4
24	0.0	5.1	5.7	5.4	5.0	4.9	5.0	5.4
25	0.0	5.4	5.4	5.1	4.9	6.1	4.4	5.5

## OVERPRESSURE SUMMARY (PSI)

DAILY AVERAGE	0.0	5.3	5.5	5.2	5.0	5.1	5.2
STD. DEV.	0.00	0.22	0.19	0.51	0.21	0.42	0.39
DAILY VARIANCE	0.00	0.05	0.04	0.26	0.04	0.18	0.15
GRAND AVERAGE AND VARIANCE		5.2	0.13				0.04
VARIANCE BETWEEN GROUPS		0.69					
VARIANCE WITHIN GROUPS		0.11					

DAILY MAX. AND SHOT NO.	0.0	0	5.6	18	5.9	3	6.6	5	5.4	21	6.1	25	5.9	13	5.5	7
DAILY MIN. AND SHOT NO.	0.0	0	4.4	6	5.2	18	4.3	3	4.7	15	4.4	14	4.4	15	4.7	15

TABLE 2-5. ESTIMATED MAXIMUM

LOWFLAME SHOCK TUBE TEST

(ON AXIS, GRAZING

ESTIMATED MAXIMUM (PSI)

SHOT	DAY1 1MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	0.0	3.7	3.7	3.7	3.8	3.7	4.1	3.7
2	0.0	3.9	4.1	4.0	3.6	4.1	3.7	3.8
3	0.0	3.7	4.0	3.4	3.4	3.7	3.6	3.7
4	0.0	3.6	4.0	3.4	3.5	4.1	4.0	3.7
5	0.0	3.9	4.1	4.0	3.6	3.4	3.7	3.7
6	0.0	3.7	3.8	3.6	3.7	3.7	3.8	3.8
7	0.0	3.7	4.1	3.6	3.6	3.7	3.7	3.8
8	0.0		4.0	3.4	3.5	3.8	3.7	3.9
9	0.0		4.0	3.4	3.7	3.7	3.7	3.7
10	0.0	3.9	3.8	3.9	3.6	3.7	3.8	3.8
11	0.0	3.9	3.9	6.1	3.6			3.8
12	0.0	3.7	4.2	3.4	3.7	3.8	3.7	3.9
13	0.0	3.8	4.0	3.6	3.7	3.3	4.1	3.8
14	0.0	3.7	3.9	4.0	3.7	3.3	3.6	3.8
15	0.0	3.9	3.9	3.4	3.4	3.5	3.0	3.6
16	0.0	4.0	3.9	3.6	3.7	3.6	4.0	3.6
17	0.0	3.9	4.1	3.8	3.7	3.5	3.5	3.6
18	0.0	4.1	3.8	3.5	3.7	3.2	3.8	3.9
19	0.0	3.9	3.8	3.1	3.8	3.7	3.5	
20	0.0	3.9	3.8		3.6	3.6		3.7
21	0.0		3.9	4.0		3.6	3.5	3.9
22	0.0	4.0	3.9	3.7	3.8	3.3	4.1	3.7
23	0.0	3.8	3.9	3.7	3.7		4.0	3.8
24	0.0	3.8	4.1	3.2	3.7	3.6	3.4	3.7
25	0.0		3.8	3.6	3.4	3.8	3.3	3.7

ESTIMATED OVERPRESSURE SUMMARY (PSI)

DAILY AVERAGE	0.0	3.8	3.9	3.7	3.6	3.7	3.6
STD. DEV.	0.00	0.12	0.12	0.58	0.10	0.23	0.77
DAILY VARIANCE	0.00	0.02	0.01	0.34	0.01	0.05	0.59
GRAND AVERAGE AND VARIANCE	3.7	0.17					
VARIANCE: BETWEEN GROUPS	0.38						
VARIANCE: WITHIN GROUPS	0.16						

DAILY MAX. AND SHOT NO.	0.0	0	4.1	18	4.2	12	6.1	11	3.8	1	4.1	4	4.1	13	3.9	12
DAILY MIN. AND SHOT NO.	0.0	0	3.6	4	3.7	1	3.1	19	3.4	3	3.2	18	3.0	15	1.6	15

TABLE 2-5 (Cont.). POSITIVE IMPULSE

## LOVELACE SHOCK TUBE TEST

## ON AIS, GRAZING

## POSITIVE IMPULSE (PSI-MS)

SHOT	DAY1 1MIN	DAY2 1MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	0.0	10.3	10.3	10.7	9.7	10.9	11.1	10.2
2	0.0	10.7	10.8	10.2	10.8	10.4	10.5	10.4
3	0.0	9.1	10.4	9.6	10.2	10.8	10.7	10.6
4	0.0	9.0	10.3	10.9	9.9	10.5	11.7	10.8
5	0.0	10.2	10.5	11.1	10.1	9.8	10.5	9.9
6	0.0	10.1	10.0	10.8	11.0	10.1	10.7	10.3
7	0.0	9.7	10.2	10.9	10.2	10.5	10.3	10.5
8	0.0		10.7	10.6	10.1	10.7	10.7	11.6
9	0.0		10.7	10.9	10.4	10.1	10.2	11.3
10	0.0	9.4	9.8	9.9	9.9	10.8	10.4	10.7
11	0.0	10.3	10.5	11.3	10.0			10.2
12	0.0	10.8	10.3	10.2	10.5	10.8	9.6	10.5
13	0.0	10.7	10.2	10.7	9.8	10.7	10.4	10.1
14	0.0	8.5	10.5	11.1	10.0	9.9	11.4	10.6
15	0.0	11.0	10.3	11.0	11.0	10.9	10.5	10.4
16	0.0	10.1	11.4	10.3	10.4	10.7	10.7	10.4
17	0.0	10.9	11.1	11.2	10.9	9.9	10.7	10.9
18	0.0	10.9	9.8	10.9	11.2	10.7	10.7	10.4
19	0.0	9.9	10.5	10.6	10.7	10.2	10.4	10.6
20	0.0	11.1	9.9	10.9	10.2	11.1	10.9	10.7
21	0.0	9.7	10.7	11.7	10.8	11.1	11.3	9.9
22	0.0	10.6	10.6	11.1	10.5	8.7	11.0	10.1
23	0.0	9.8	10.6	11.1	11.0		10.7	9.7
24	0.0	9.2	9.9	10.9	10.5	11.1	10.8	10.6
25	0.0	9.8	10.5	10.9	10.3	10.4	11.2	10.3

POSITIVE IMPULSE SUMMARY (PSI-MS)								
DAILY AVERAGE	0.0	10.0	10.4	10.8	10.4	10.5	10.7	10.5
STD. DEV.	0.00	0.71	0.38	0.46	0.42	0.55	0.44	0.42
DAILY VARIANCE	0.00	0.50	0.15	0.21	0.18	0.30	0.19	0.17
GRAND AVERAGE AND VARIANCE	10.5 0.20							
VARIANCE BETWEEN GROUPS	1.38							
VARIANCE WITHIN GROUPS	0.24							

DAILY MAX. AND SHOT NO.	0.0	0	11.1	20	11.4	16	11.7	21	11.2	18	11.1	24	11.7	4	11.6	8
DAILY MIN. AND SHOT NO.	0.0	0	8.5	14	9.8	18	9.6	1	9.7	1	8.7	22	9.6	12	9.7	23

TABLE 2-5 (Cont.). RECORDED MAXIMUM

LOVELACE SHOCK TUBE TEST

OFF AXIS, FACE-ON

RECORDED MAXIMUM (PSI)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	11.2	11.5	10.9	11.9	11.4	12.1	12.5	11.0
2	9.6	10.4	12.8	13.1	12.9	12.2	10.5	13.4
3	10.6	12.0	13.1	12.7	11.2	11.7	12.0	12.9
4	9.4	9.9	13.2	11.3	11.0	0.0	12.9	11.6
5	9.9	8.9	13.3		12.2	0.0	10.5	11.9
6	8.7	10.3	12.1	9.8	10.9	0.0	11.1	12.2
7	9.3	10.7	13.4	12.4	12.1	0.0	10.1	11.2
8	10.1		12.5	11.3	10.1	0.0	11.0	11.1
9	10.4	8.6	11.7	9.4	11.5	0.0	10.4	13.1
10	8.8	10.2	13.3	9.8	11.5	0.0	10.3	12.4
11	10.2	11.6	12.4	9.6	12.4	0.0		12.7
12	8.8	10.3	14.0	9.7	12.6	0.0	11.0	12.1
13	11.7	10.5	12.2	9.7	11.8	0.0	10.9	12.4
14	9.7	10.7	13.3	8.3	12.6	0.0	11.3	11.7
15	10.8	10.2	13.5	10.8	11.4	0.0	11.8	11.7
16	9.6	10.2	12.3	12.7	10.7	0.0	11.0	11.6
17	10.4	10.4	13.5	12.3	12.6	0.0	10.4	11.5
18	11.5	12.3	12.5	10.0	11.4	0.0	11.5	12.6
19	11.1	11.0	12.6	8.8	11.7	0.0	11.3	12.5
20	11.8	12.1	13.5	10.1	11.4	0.0	11.6	11.9
21	10.3	12.1	12.3	11.2	13.3	0.0	9.9	13.1
22	10.5	11.2	13.8	10.6	12.0	0.0	12.4	12.3
23	11.6	11.5	12.6	10.6	12.7	0.0	11.5	11.9
24	11.1	11.5	12.6	9.5	11.0	0.0	10.9	11.4
25	11.7	11.6	11.6	8.6	11.2	0.0	10.3	12.5

OVERPRESSURE SUMMARY (PSI)

DAILY AVERAGE	10.4	10.8	12.8	10.6	11.7	12.1
STD. DEV.	0.96	0.96	0.75	1.39	0.76	0.66
DAILY VARIANCE	0.91	0.92	0.56	1.92	0.58	0.43
GRAND AVERAGE AND VARIANCE	11.4 1.48					
VARIANCE BETWEEN GROUPS	19.01					
VARIANCE WITHIN GROUPS	0.85					

DAILY MAX. AND SHOT NO.	11.8	20	12.3	18	14.0	12	13.1	2	13.3	21	12.2	2	12.9	4	13.4	2
DAILY MIN. AND SHOT NO.	8.7	6	8.6	9	10.9	1	8.3	14	10.1	8	11.7	3	9.9	21	11.0	1

TABLE 2-5 (Cont.). ESTIMATED MAXIMUM

DISPLACE SHOCK TUBE TEST

OFF AXIS, FACE-ON

ESTIMATED MAXIMUM (PSI)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	4.8	5.1	5.4	5.4	5.5	0.1	5.1	5.6
2	4.7	5.3	5.7	5.4	5.4	5.7	4.7	5.6
3	4.8	5.0	5.7	5.1	4.8	0.1	4.8	5.4
4	4.6	5.0	5.5	5.2	5.2	0.0	5.2	5.5
5	5.0	5.1	5.7		5.3	0.0	4.2	5.5
6	5.0	4.7	5.4	4.2	5.3	0.0	4.5	5.6
7	4.9	4.8	5.6	5.2	5.2	0.0	4.3	5.4
8	5.1		5.8	4.5	5.1	0.0	5.1	5.6
9	4.9	5.1	5.6	4.4	5.6	0.0	4.6	5.4
10	4.6	5.1	5.6	4.4	5.1	0.0	4.6	5.8
11	4.7	5.2	5.8	4.4	5.1	0.0		5.6
12	4.7	4.8	6.0	4.8	5.4	0.0	4.7	5.8
13	5.2	5.1	5.7	4.4	5.4	0.0	5.1	5.3
14	4.9	5.2	5.7	3.6	5.6	0.0	4.8	5.3
15	4.7	5.3	5.6	4.4	5.7	0.0	5.3	5.3
16	4.9	5.2	6.2	5.2	5.2	0.0	4.8	5.3
17	5.0	5.5	5.8	4.9	5.4	0.0	4.6	5.2
18	5.0	5.4	5.6	4.3	5.5	0.0	4.7	5.4
19	4.9	5.3	5.3	4.0	5.6	0.0	4.8	5.5
20	5.0	5.0	5.7	4.4	5.1	0.0	4.9	5.4
21	4.8	5.0	5.6	4.7	5.7	0.0	4.8	5.6
22	5.1	5.5	5.9	4.6	5.5	0.0	5.3	5.3
23	5.1	5.1	5.5	4.4	5.4	0.0	5.1	5.4
24	5.2	4.9	5.2	3.9	5.2	0.0	4.9	5.5
25	5.1	5.2	5.3		5.0	0.0	4.9	5.5

ESTIMATED OVERPRESSURE SUMMARY (PSI)

DAILY AVERAGE	4.9	5.1	5.6	5.3	0.0	4.8	5.5
STD. DEV.	0.18	0.20	0.21	0.23	0.00	0.29	0.16
DAILY VARIANCE	0.03	0.04	0.04	0.05	0.00	0.08	0.03

GRAND AVERAGE AND VARIANCE 5.1 0.18

VARIANCE BETWEEN GROUPS 3.33

VARIANCE WITHIN GROUPS 0.07

DAILY MAX. AND SHOT NO.	5.2 13	5.5 22	6.2 16	5.4 1	5.7 21	5.3 15	5.8 12
DAILY MIN. AND SHOT NO.	4.6 10	4.7 6	5.2 24	3.6 14	4.8 3	4.2 5	5.7 17

TABLE 2-6. POSITIVE IMPULSE

LOVEPLATE SHOCK TUNE TEST

LEFT AXIS, FACE-ON

POSITIVE IMPULSE (PSI-MS)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 14MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	13.5	14.3	16.4	16.3	16.3	15.9	14.4	16.7
2	12.9	14.1	17.0	14.4	16.6	17.3	14.0	16.8
3	13.7	14.4	16.2	15.1	15.5	0.1	13.9	16.6
4	12.5	13.9	16.7	14.9	15.5	0.0	14.3	17.5
5	14.0	14.4	16.4	16.0	16.7	0.0	13.7	15.9
6	13.8	14.2	15.9	15.2	15.8	0.0	13.6	16.4
7	11.9	14.4	16.8	15.1	15.7	0.0	13.2	16.7
8	13.5		16.6	14.7	15.6	0.0	14.3	17.4
9	13.3	15.0	16.2	15.4	16.6	0.0	14.1	17.2
10	13.2	14.5	17.0	15.1	14.9	0.0	13.8	18.4
11		15.0	16.6	15.4	14.4	0.0		17.0
12	13.6	14.0	16.9	14.6	15.2	0.0	13.2	17.6
13	13.8	14.0	16.5	15.0	15.3	0.0	14.5	15.8
14	13.0	14.9	16.6	14.9	15.6	0.0	14.3	16.9
15	13.5	14.0	16.5	15.5	15.2	0.0	14.7	16.7
16	13.6	14.9	17.8	14.6	16.0	0.0	14.6	16.5
17	13.5	14.7	16.4	15.5	17.0	0.0	14.2	15.3
18	13.8	14.6	17.0	14.8	16.2	0.0	13.8	16.9
19	13.5	14.5	16.6	16.2	16.9	0.0	14.2	16.5
20	14.3	14.5	16.7	15.4	16.0	0.0	14.2	15.4
21	13.6	14.2	16.5	16.6	16.0	0.0	14.9	16.8
22	12.1	16.1	16.6	15.5	16.1	0.0	14.4	15.7
23	13.7	14.2	15.8	15.4	17.4	0.0	14.0	15.3
24	13.6	14.6	15.7	15.2	16.5	0.0	14.0	15.4
25	14.0	14.3	16.8	15.0	15.6	0.0	14.3	16.2

POSITIVE IMPULSE SUMMARY (PSI-MS)

TYPE: AVERAGE SUMMARY (0.33) (4)								
DAILY AVERAGE	13.4	14.5	16.6	15.3	15.9	0.0	14.1	16.5
STD. DEV.	0.58	0.47	0.43	0.56	0.69	0.00	0.42	0.79
DAILY VARIANCE	0.33	0.22	0.19	0.31	0.48	0.00	0.18	0.62
GRAND AVERAGE AND VARIANCE	15.2		1.62					
VARIANCE BETWEEN GROUPS	37.09							
VARIANCE WITHIN GROUPS	0.33							

DAILY MAX. AND SHOT NO.	14.3	20	16.1	22	17.8	16	16.6	21	17.4	23	17.3	2	14.9	21	18.4	10
DAILY MIN. AND SHOT NO.	11.9	7	11.9	4	15.7	24	14.4	2	14.4	11	0.1	3	13.2	12	15.3	23

TABLE 2-6 (Cont.). RECORDED MAXIMUM

## LOVELACE SHOCK TUBE TEST

## OFF AXIS, GRAZING

## RECORDED MAXIMUM (PSI)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	5.8		5.2	5.2	5.8	5.4	5.4	5.8
2	5.1	5.7	5.4	5.4	5.1	5.8	5.3	5.7
3	5.9	5.5	5.4	5.3	4.8	4.8	5.5	5.3
4	5.3	5.6	5.8	5.3	4.8	4.8	5.8	5.1
5	5.6	5.4	5.8	3.8	5.3	5.4	4.6	5.6
6	6.6	5.4	5.6	3.8	5.1	5.2	5.1	5.4
7	5.6	5.2		5.0	5.3	5.9	4.7	5.5
8	5.1		5.6	4.9	5.3	5.1	5.5	5.2
9	5.9	5.5	5.6	4.6	5.7	5.4	5.1	5.2
10	5.7	5.5	5.3	4.2	5.1	5.5	4.9	5.2
11	4.9	5.3	5.3	4.4	5.4			5.4
12	6.1	5.1	5.4	4.7	5.7	5.7	4.8	5.4
13	5.3	5.7	5.7	4.3	5.6	5.2	5.1	5.1
14	5.4	5.9	5.5	3.6	5.5	5.2	4.9	5.5
15	6.3	5.6	5.4	4.4	5.6	5.2	5.7	5.2
16	6.6	5.8	5.5	5.0	5.1	5.3	5.1	5.2
17	5.0	5.8	5.9	5.0	5.2	5.3	5.0	5.1
18	6.1	6.0	5.1	4.6	5.6	5.2	5.2	5.3
19	6.2	5.7	5.3	4.0	5.6	5.3	5.1	5.4
20	6.4	5.2	5.2	5.3	4.8	5.7	5.5	5.2
21	6.1	5.8	5.4	4.7	5.8	4.5	5.0	5.7
22	6.1	6.0	5.3	4.9	5.4	4.9	5.8	4.9
23	5.5	5.5	6.0	4.5	5.3		5.1	5.4
24	6.6	5.2	5.4	5.0	5.3	5.3	5.0	5.4
25	5.5	5.7	5.0	3.2	4.9	5.4	5.5	5.0

## OVERPRESSURE SUMMARY (PSI)

DAILY AVERAGE	5.8	5.6	5.5	4.6	5.3	5.3	5.2	5.3
STD. DEV.	0.51	0.26	0.25	0.60	0.30	0.32	0.33	0.22
DAILY VARIANCE	0.26	0.07	0.06	0.35	0.09	0.10	0.11	0.05
GRAND AVERAGE AND VARIANCE	5.3 0.24							

VARIANCE BETWEEN GROUPS 2.93

VARIANCE WITHIN GROUPS 0.14

DAILY MAX. AND SHOT NO.	6.6 16	6.0 18	6.0 23	5.4 2	5.8 21	5.9 7	5.8 4	5.8 1
DAILY MIN. AND SHOT NO.	4.9 11	5.1 12	5.0 25	3.2 25	4.8 20	4.5 21	4.6 5	4.9 22



TABLE 2-6 (Cont.). POSITIVE IMPULSE

## LOWPLACE SHOCK TUBE TEST

## OFF AXIS, GRAZING

## POSITIVE IMPULSE (PSI-MS)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	9.7	9.5	9.8	10.4	9.5	10.8	10.4	9.4
2	9.2	10.5	9.2	10.4	9.6	10.8	10.4	9.5
3	9.6	10.4	9.7	8.9	10.2	10.7	10.5	10.4
4	9.5	10.0	9.5	10.0	10.4	10.2	10.8	10.6
5	9.6	10.3	10.5	9.8	9.5	10.1	10.5	10.1
6	9.4	9.9	10.1	10.2	9.6	10.4	9.5	10.4
7	9.7	10.2	10.5	10.2	10.1	10.7	10.1	10.9
8	9.8	10.3	10.3	10.2	10.2	9.9	10.6	9.5
9	10.0	10.3	10.3	10.7	9.6	10.2	10.4	9.6
10	9.9	10.2	10.1	10.2	10.0	10.3	10.4	10.9
11	9.3	9.8	9.5	10.7	9.9	10.2	10.1	10.6
12	9.7	9.8	9.4	10.1	10.3	10.2	10.1	9.8
13	9.8	9.7	9.4	10.4	9.3	9.9	10.1	9.6
14	9.6	10.4	10.4	10.5	10.2	9.0	10.4	10.8
15	9.1	10.1	9.4	10.7	10.5	10.5	10.1	10.5
16	10.0	9.7	10.5	9.7	10.5	10.5	10.8	10.4
17	9.3	10.0	11.0	10.5	10.2	9.9	10.4	10.2
18	9.9	10.5	9.0	10.4	10.2	10.1	10.4	10.6
19	9.0	10.3	9.6	10.2	9.8	9.5	10.3	10.1
20	10.1	10.7	10.2	9.6	10.4	10.5	10.3	10.0
21	9.3	10.4	9.7	10.6	9.6	10.5	11.1	10.6
22	9.0	10.2	10.2	10.4	9.5	10.2	10.6	10.2
23	9.8	9.8	10.4	10.3	10.2	10.2	10.2	9.5
24	10.0	10.5	9.4	10.4	10.1	10.3	10.5	9.9
25	10.0	10.3	10.4	10.1	9.4	10.2	10.3	10.3

## POSITIVE IMPULSE SUMMARY (PSI-MS)

DAILY AVERAGE	9.6	10.2	10.0	10.2	10.0	10.1	10.4	10.2
STD. DEV.	0.33	0.29	0.52	0.46	0.37	0.40	0.34	0.47
DAILY VARIANCE	0.11	0.08	0.27	0.21	0.14	0.16	0.12	0.22
GRAND AVERAGE AND VARIANCE	10.1 0.21							
VARIANCE: BETWEEN GROUPS	1.37							
VARIANCE: WITHIN GROUPS	0.16							

DAILY MAX. AND SHOT NO.	10.1	20	10.7	20	11.0	17	10.7	15	10.5	16	10.7	7	11.1	21	10.9	10
DAILY MIN. AND SHOT NO.	9.0	22	9.7	10	9.0	18	8.9	3	9.3	13	9.0	14	9.5	6	9.4	1

TABLE 2-6 (Cont.). ESTIMATED MAXIMUM

LOVELACE SHUCK TUBE TEST

OFF AXIS, CHAZING

ESTIMATED MAXIMUM (PSI)

SHOT	DAY1 3MIN	DAY2 3MIN	DAY3 1MIN	DAY4 20SEC	DAY5 1MIN	DAY6 30SEC	DAY7 30SEC	DAY8 1MIN
1	3.7	4.0	3.9	3.9	4.1	4.1	4.2	4.0
2	3.7	4.0	4.1	3.7	3.9	4.1	3.8	4.1
3	3.8	3.9	4.1	3.7	3.7	3.3	4.0	3.9
4	3.8	3.9	4.0	3.8	4.0	3.3	4.2	4.1
5	4.0	3.9	4.2	2.5	4.0	3.9	3.5	4.0
6	3.8	3.8	3.9	2.9	3.9	4.1	3.9	4.0
7	3.8	3.8	3.9	3.6	3.9	4.1	3.5	4.0
8	3.7	4.0	4.1	3.1	3.9	3.8	4.1	4.0
9	3.6	4.0	4.1	3.2	4.2	4.1	3.9	3.9
10	3.7	3.9	4.0	3.1	3.9	4.1	3.6	4.1
11	3.8	4.0	4.0	3.1	4.0	4.1	3.7	4.1
12	3.7	3.8	4.1	3.4	4.1	4.0	3.7	3.8
13	4.0	3.9	4.1	3.1	4.1	3.7	3.8	3.9
14	3.8	4.1	4.0	2.5	4.1	3.4	3.8	3.9
15	3.6	4.0	4.0	3.1	4.2	3.7	4.4	3.6
16	3.8	3.9	3.9	3.6	3.8	3.6	3.6	3.8
17	3.4	4.2	4.3	3.5	4.0	3.7	4.0	3.8
18	3.9	4.0	4.0	3.1	4.2	3.8	3.7	4.0
19	3.8	4.0	4.0	3.0	4.1	3.8	3.7	3.9
20	3.8	3.9	3.8	3.2	3.8	4.1	4.1	4.0
21	3.8	4.0	4.1	3.3	4.2	3.3	3.8	4.0
22	3.9	4.1	3.9	3.4	4.1	3.3	4.0	3.8
23	4.0	4.0	4.2	3.2	3.9	4.0	4.0	4.0
24	3.8	3.8	3.8	2.7	3.9	4.0	3.8	4.1
25	3.9	4.0	3.9	3.3	3.8	3.7	3.9	4.0

ESTIMATED OVERPRESSURE SUMMARY (PSI)

DAILY AVERAGE	3.8	4.0	4.0	3.3	4.0	3.8	4.0
STD. DEV.	0.08	0.10	0.11	0.16	0.14	0.28	0.09
DAILY VARIANCE	0.01	0.01	0.01	0.13	0.02	0.08	0.01
GRAND AVERAGE AND VARIANCE	1.8	0.09					
VARIANCE BETWEEN GROUPS	1.53						
VARIANCE WITHIN GROUPS	0.04						

DAILY MAX. AND SHOT NO.	4.0 13	4.2 17	4.3 17	3.9 1	4.2 21	4.1 9	4.4 15	4.1 12
DAILY MIN. AND SHOT NO.	3.6 15	3.8 24	3.8 24	2.5 5	3.7 3	1.3 22	3.5 5	3.8 27

in May were less than during the March tests. Though not as striking, the standard deviations in positive impulse given in Table 2-8 show similar conclusions. Finally, the shot-to-shot correlation coefficients given in Table 2-10 show that on Day 8 of the May test, the shock tube correlated with the coefficient of 0.95 to 0.96. The three shots chosen from Day 4 of the March test were of near equal coefficients but the three shots from Day 5 of the March test did not correlate as well. For other shot-to-shot correlations of the March test, see Reference 1.

The minimum correlations were comparable for the March and May firings of the shock tube.

From the data in Table 2-7, it is obvious that as the time between shots increased from 20 sec to 1 min, the ratio of the standard deviation in peak pressures to average peak pressure decreased considerably. This indicates that the larger repetition rates lead to less variance in shot-to-shot peak pressures. However, the data in Table 2-8 does not indicate similar conclusions can be drawn about the positive impulse. It appears that this parameter is insensitive to the rate of firing.

On a given day the shot-to-shot reproducibility of the shock tube is comparable to that of the M198.

When data from different days are considered, there is evidence of a discernable difference in the performance of the shock tube and also the M198. There could be several reasons for this: atmospheric conditions, topographic variations, slight changes in gauge placement (a variation of a foot can show considerable change in the structure of the pressure time history as explained in Volume II and IV of reports), changes in the response and performance of the recording equipment, changes in powder and primercord, etc. These variations seem to be unavoidable, but since the M198 will be fired under a variety of conditions, it is not unreasonable to accept some day to day variation in the performance of the shock tube as long as it is carefully monitored.

TABLE 2-7 RATIOS OF THE STANDARD DEVIATIONS  
OF THE PEAK RECORDED PRESSURES TO THE  
AVERAGE PEAK RECORDED PRESSURE X 100%

Shock Tube 25 Shots March Test	Time Between Shots	Gauge 1	Gauge 2	Gauge 3	Gauge 4
Day 1	20s	9.0	7.3	--	8.9
Day 2	20s	18.0	14.6	10.0	10.3
Day 3	20s	17.0	13.8	13.5	13.2
Day 4	20s	12.8	9.5	7.3	7.7
Day 5	20s	18.9	16.2	13.8	12.8
<u>May Test</u>					
Day 1	3m	10.5	--	9.2	8.8
Day 2	3m	5.0	4.2	8.9	4.6
Day 3	1m	4.7	3.5	5.9	4.5
Day 4	20s	9.5	9.8	13.1	13.0
Day 5	1m	6.7	4.2	6.5	5.7
Day 6	30s	9.1	8.2	--	6.0
Day 7	30s	8.2	7.5	7.1	6.3
Day 8	1m	4.9	4.0	5.5	4.2

Average Value for Time Interval

Time Between Shots	Gauge 1	Gauge 2	Gauge 3	Gauge 4
3m*	2.6	7.1	3.2	2.8
1m	4.4	3.9	3.9	4.5
30s	5.4	4.7	3.0	3.7
20s-May	3.3	4.3	3.7	4.5
20s-Mar	7.7	3.0	3.4	3.5

\*Day 1 omitted because of signal quality. See Table 3-2.

M198

Nov 78

Position	Qe/AZ	Gauge Ht.	No. Shots	St.D./Ave. Peak	X 100%
C22	267/0	4'	3	2.4	
C22	800/0	5'	3	3.9	

May 79

C22	267/0	5'	12	7.6	
C22	800/0	5'	12	3.5	

TABLE 2-8 RATIOS OF THE STANDARD  
DEVIATION OF THE POSITIVE IMPULSE TO THE  
AVERAGE POSITIVE IMPULSE X 100%

Shock Tube 25 Shots March Test	Time Between Shots	Gauge 1	Gauge 2	Gauge 3	Gauge 4
Day 1	20s	--	2.3	--	2.8
Day 2	20s	7.2	3.4	3.7	3.5
Day 3	20s	7.2	3.4	4.0	4.3
Day 4	20s	4.6	1.8	3.0	3.3
Day 5	20s	11.8	3.9	2.7	3.4
<u>May Test</u>					
Day 1	3m	2.6	--	4.3	3.4
Day 2	3m	2.6	7.1	3.2	2.8
Day 3	1m	3.7	3.7	2.6	5.2
Day 4	20s	3.3	4.3	3.7	4.5
Day 5	1m	3.9	4.0	4.3	3.7
Day 6	30s	5.0	5.2	--	4.0
Day 7	30s	5.7	4.1	3.0	3.3
Day 8	1m	5.6	4.0	4.8	4.6
Average Value for Time Interval					
	3m*	2.6	7.1	3.2	2.8
	1m	4.4	3.9	3.9	4.5
	30s	5.4	4.7	3.0	3.7
	20s-May	3.3	4.3	3.7	4.5
	20s-Mar	7.7	3.0	3.4	3.5

\*Day 1 omitted because of signal quality. See Section C

TABLE 2-9 M198 CORRELATIONS

C22			4'		QE/AZ = 267/0		Nov 78				
50ms Correlation							Minimum Correlation				
Shot	15	17			14	15	17				
<u>14</u>	.94	.94			<u>15</u>	.83	.73				
<u>15</u>		.94					.88				
C22			5'		QE/AZ = 800/0		Nov 78				
50ms Correlation							Minimum Correlation				
Shot	31	32			30	31	32				
<u>30</u>	.92	.92			<u>31</u>	.87	.90				
<u>31</u>		.92					.90				
C22			5'		QE/AZ = 267/0		May 79				
50ms Correlation											
Shot	5	6	13	14	15	22	23	24	31	32	33
4	0.93	0.89	0.93	0.92	0.93	0.93	0.93	0.93	0.89	0.91	0.91
5		0.93	0.94	0.92	0.93	0.93	0.92	0.92	0.91	0.93	0.93
6			0.92	0.91	0.91	0.90	0.92	0.92	0.93	0.91	0.93
13				0.93	0.93	0.93	0.93	0.94	0.92	0.92	0.93
14					0.92	0.92	0.93	0.92	0.90	0.92	0.93
15						0.94	0.91	0.91	0.91	0.94	0.93
22							0.92	0.92	0.90	0.93	0.92
23								0.94	0.91	0.91	0.92
24									0.91	0.90	0.91
31										0.91	0.92
32											0.91
Minimum Correlation											
Shot	5	6	13	14	15	22	23	24	31	32	33
4	0.93	0.89	0.91	0.92	0.91	0.93	0.92	0.91	0.89	0.91	0.91
5		0.92	0.94	0.92	0.93	0.93	0.90	0.87	0.91	0.92	0.93
6			0.92	0.91	0.91	0.90	0.89	0.92	0.91	0.90	0.93
13				0.92	0.93	0.93	0.88	0.93	0.92	0.91	0.93
14					0.92	0.90	0.89	0.92	0.90	0.92	0.93
15						0.94	0.89	0.87	0.91	0.92	0.93
22							0.89	0.90	0.90	0.92	0.92
23								0.88	0.91	0.91	0.89
24									0.88	0.90	0.90
31										0.91	0.89
32											0.91
C22			5'		QE/AZ = 800/0		May 78				
50ms Correlation							Minimum Correlation				
Shot	10	11			3	10	11				
<u>3</u>	.90	.91			<u>10</u>	.39	.90				
<u>10</u>		.89					.84				

TABLE 2-10 SHOCK TUBE CORRELATIONS

		Gauge 2		On-Axis,		Grazing		March 79				
		50ms Correlation				Minimum Correlation						
Day 5	Shot	<u>16</u>	<u>21</u>			<u>16</u>	<u>21</u>					
	<u>6</u>	.84	.86			<u>6</u>	.70		.76			
	<u>15</u>		.94			<u>15</u>			.74			
		50ms Correlation				Minimum Correlation						
Day 4	Shot	<u>15</u>	<u>22</u>			<u>15</u>	<u>22</u>					
	<u>3</u>	.97	.95			<u>3</u>	.91		.86			
	<u>15</u>		.96			<u>15</u>			.92			
		Gauge 2		On Axis,		Grazing		May 79				
		50ms Correlation										
Day 8	Shot	2	3	4	5	6	7	8	9	10	11	12
	1	0.97	0.96	0.96	0.96	0.97	0.96	0.97	0.97	0.95	0.97	0.95
	2		0.96	0.96	0.96	0.98	0.97	0.98	0.97	0.96	0.97	0.96
	3			0.96	0.97	0.95	0.95	0.95	0.95	0.93	0.95	0.93
	4				0.97	0.96	0.96	0.97	0.96	0.94	0.97	0.95
	5					0.95	0.95	0.95	0.95	0.94	0.96	0.94
	6						0.96	0.97	0.97	0.95	0.97	0.96
	7							0.97	0.97	0.97	0.96	0.97
	8								0.97	0.96	0.97	0.96
	9									0.96	0.97	0.96
	10										0.95	0.97
	11											0.96
		Minimum Correlation										
Day 8	Shot	2	3	4	5	6	7	8	9	10	11	12
	1	0.92	0.81	0.69	0.84	0.94	0.80	0.92	0.94	0.70	0.90	0.74
	2		0.80	0.70	0.83	0.96	0.84	0.95	0.92	0.73	0.87	0.79
	3			0.67	0.96	0.76	0.71	0.77	0.79	0.66	0.82	0.65
	4				0.89	0.86	0.76	0.85	0.87	0.67	0.91	0.70
	5					0.80	0.73	0.79	0.81	0.68	0.85	0.67
	6						0.81	0.95	0.92	0.69	0.89	0.76
	7							0.84	0.84	0.82	0.80	0.91
	8								0.94	0.71	0.89	0.78
	9									0.73	0.90	0.78
	10										0.70	0.85
	11											0.74

TABLE 2-10 (Cont'd)  
CORRELATIONS OF DIFFERENT DAYS

		Gauge 2		On Axis,		Grazing		May 79						
		50ms Correlation												
Day		2	3	3	4	4	5	5	6	6	7	7	8	8
Shot		18	4	18	4	18	4	17	4	18	4	18	5	18
2	4	0.95	0.93	0.96	0.91	0.91	0.95	0.90	0.94	0.89	0.94	0.93	0.95	0.93
2	18		0.95	0.96	0.91	0.93	0.93	0.94	0.93	0.88	0.94	0.93	0.97	0.96
3	4			0.95	0.90	0.94	0.91	0.96	0.90	0.86	0.92	0.91	0.95	0.97
3	18				0.91	0.93	0.95	0.92	0.94	0.88	0.94	0.94	0.97	0.95
4	4					0.92	0.92	0.89	0.94	0.93	0.94	0.94	0.91	0.90
4	18						0.91	0.92	0.91	0.88	0.92	0.91	0.94	0.93
5	4							0.89	0.95	0.91	0.95	0.95	0.94	0.91
5	17								0.88	0.83	0.90	0.88	0.94	0.95
6	4									0.93	0.95	0.97	0.94	0.91
6	18										0.92	0.93	0.88	0.85
7	4											0.96	0.94	0.92
7	18												0.94	0.91
8	5													0.96

		Minimum Correlations												
Day		2	3	3	4	4	5	5	6	6	7	7	8	8
Shot		18	4	18	4	18	4	17	4	18	4	18	5	18
2	4	0.84	0.74	0.90	0.74	0.69	0.88	0.58	0.85	0.68	0.85	0.84	0.86	0.75
2	18		0.81	0.87	0.69	0.77	0.74	0.70	0.78	0.60	0.75	0.76	0.90	0.81
3	4			0.76	0.64	0.75	0.64	0.79	0.61	0.48	0.66	0.62	0.81	0.88
3	18				0.74	0.79	0.85	0.60	0.87	0.67	0.84	0.87	0.93	0.80
4	4					0.64	0.79	0.48	0.85	0.80	0.83	0.83	0.69	0.62
4	18						0.66	0.49	0.61	0.59	0.68	0.63	0.80	0.71
5	4							0.44	0.89	0.77	0.88	0.88	0.78	0.63
5	17								0.47	0.37	0.50	0.47	0.63	0.68
6	4									0.77	0.90	0.95	0.80	0.65
6	18										0.74	0.77	0.59	0.43
7	4											0.89	0.76	0.66
7	18												0.79	0.54
8	5													0.86



TABLE 2-11 CORRELATIONS BETWEEN TESTS

May 79 C22				- Nov 78 QE/AZ 800/0					
M198 5'				M198					
50ms Correlations				Minimum Correlations					
Nov	May	3	10	11	Nov	May	3	10	11
30		.88	.88	.85	30		.75	.84	.77
31		.85	.88	.85	31		.81	.86	.81
32		.84	.87	.84	32		.78	.85	.80

March Shock Tube				- Nov 78			
Gauge Ensemble				M198			
50ms Correlation				Minimum Correlation			
.84				.74			

May Shock Tube					-	Nov 78		M198					
50ms Correlations					Minimum Correlations								
Gun Shot	Tube Day Shot	7	7	8	8	Gun Shot	Tube Day Shot	7	7	8	8		
14		.78	.74	.77	.77	14		.30	.12	.35	.43		
15		.78	.74	.78	.78	15		.33	.17	.51	.37		
17		.82	.78	.80	.79	17		.53	.37	.56	.44		

May Shock Tube						March Shock Test					
50ms Correlation						Minimum Correlations					
Mar Day Shot	May Day Shot	7	7	8	8	Mar Day Shot	May Day Shot	7	7	8	8
		4	18	5	18			4	18	5	18
5	6	.83	.83	.81	.80	5	6	.59	.62	.54	.50
5	16	.87	.86	.89	.90	5	16	.65	.57	.78	.70
5	21	.91	.90	.90	.91	5	21	.80	.75	.73	.70

TABLE 2-12 STANDARD DEVIATION, SKEWNESS AND  
KURTOSIS OF 50 MS RECORDS, M198 AND SHOCK TUBE

<u>M 198</u>	<u>Nov 78</u>	<u>SHOT</u>	<u>ST.D</u>	<u>SKEW.</u>	<u>KURT.</u>
C22	5' 800/0	30	.525	1.77	8.17
		31	.500	1.66	7.81
		32	.515	1.56	7.16
C22	4' 267/0	14	.598	1.61	6.92
		15	.603	1.76	7.37
		17	.584	1.76	6.96
M198	May 79				
C22	5' 800/0	3	.467	1.52	6.55
		10	.464	1.54	6.78
		11	.478	1.68	7.19
C22	5' 267/0	4	0.552	2.108	8.292
		5	0.538	1.907	8.050
		6	0.551	1.621	6.473
		13	0.537	1.853	7.159
		14	0.560	1.752	6.597
		15	0.547	1.861	7.800
		22	0.554	1.821	7.403
		23	0.542	1.833	6.884
		24	0.575	1.999	7.773
		31	0.552	1.451	5.751
		32	0.551	1.620	6.486
		33	0.550	2.017	8.166
Tube	Mar 78				
Day 4		3	.763	2.57	10.4
		15	.762	2.68	11.5
		22	.748	2.56	10.2
Day 5		6	.710	2.69	12.6
16		.730	2.85	12.6	
21		.678	2.55	10.3	
Tube	May 78				
Day 2		4	0.785	3.005	13.767
18		0.829	2.807	11.453	
4		0.829	2.885	11.871	
18		0.808	2.958	12.724	
4		0.779	2.816	11.309	
18		0.788	2.962	12.243	
4		0.776	2.980	12.610	
17		0.839	2.903	11.576	
4		0.744	3.055	13.350	
18		0.709	2.787	11.346	
4		0.790	2.727	10.963	
18		0.784	2.908	12.226	
5		0.778	2.914	11.866	
18		0.810	2.868	11.608	

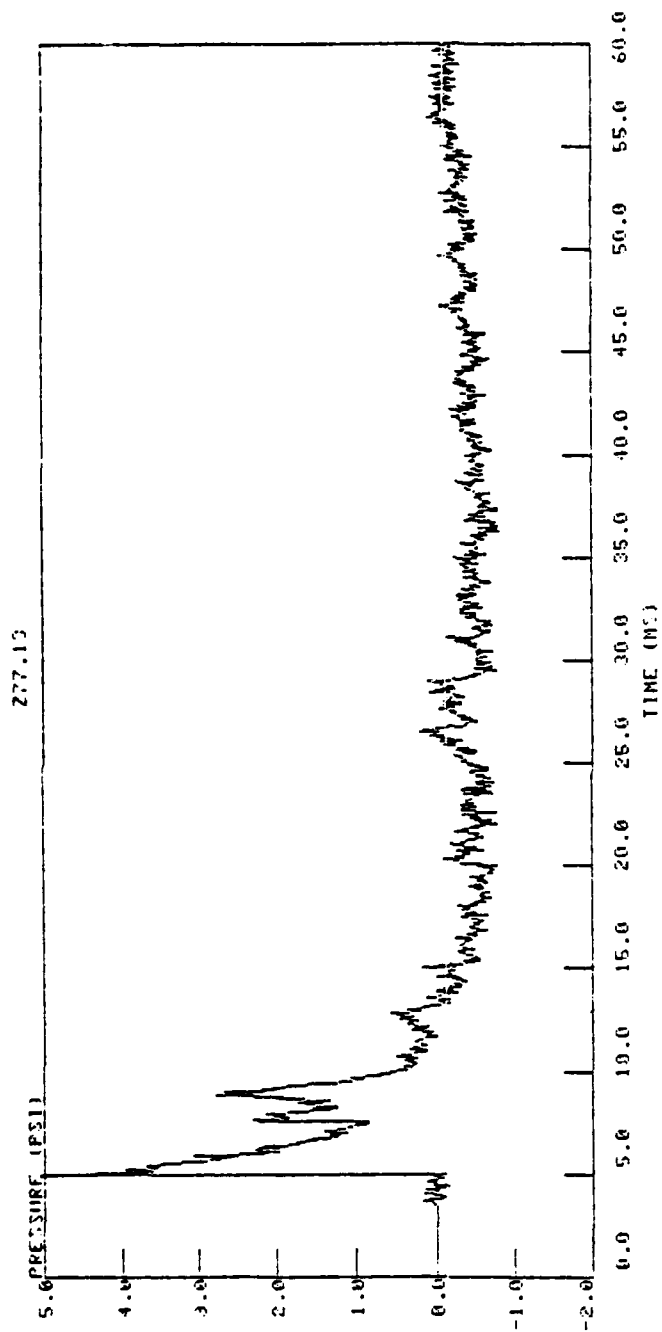
## SECTION 5 GRAPHS

### 5-1 GRAPHS

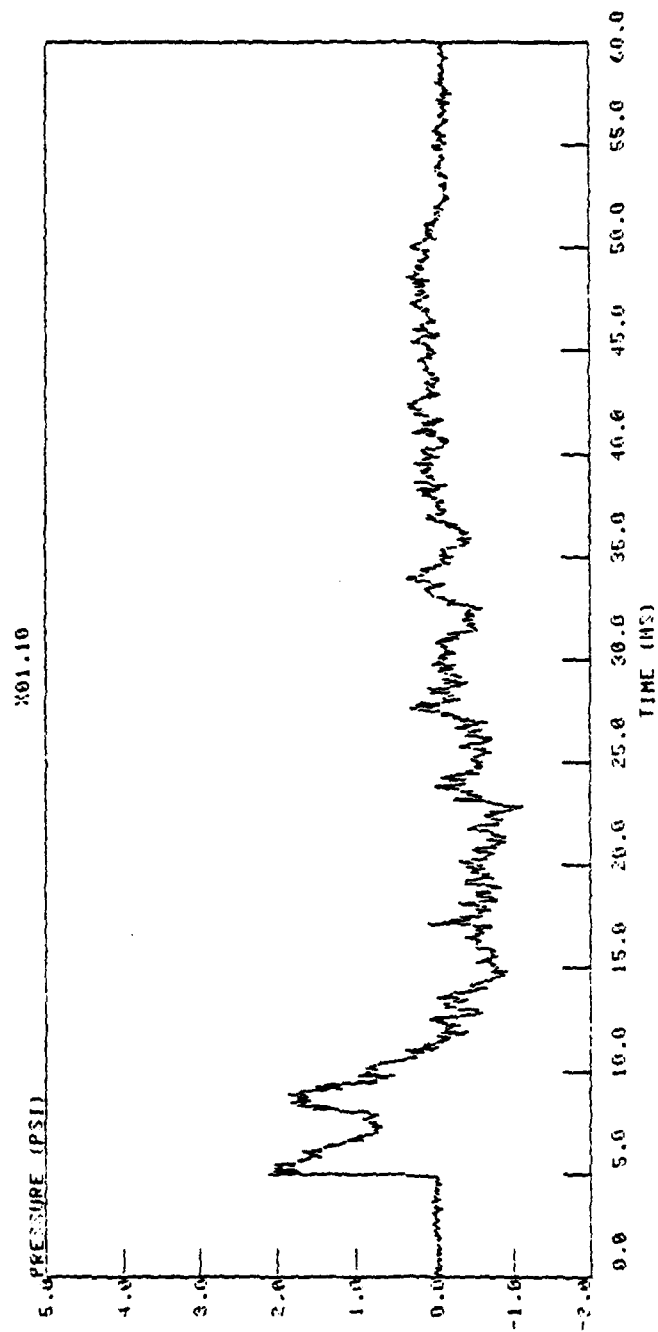
This section contains graphs of the shots analyzed in Section 2-3. A listing of each of the graphs is provided. Although many pressure time histories were examined during the analysis, only the pressure time histories that had a significant impact on the analysis are incorporated in this section. A listing of these graphs are:

#### Graph

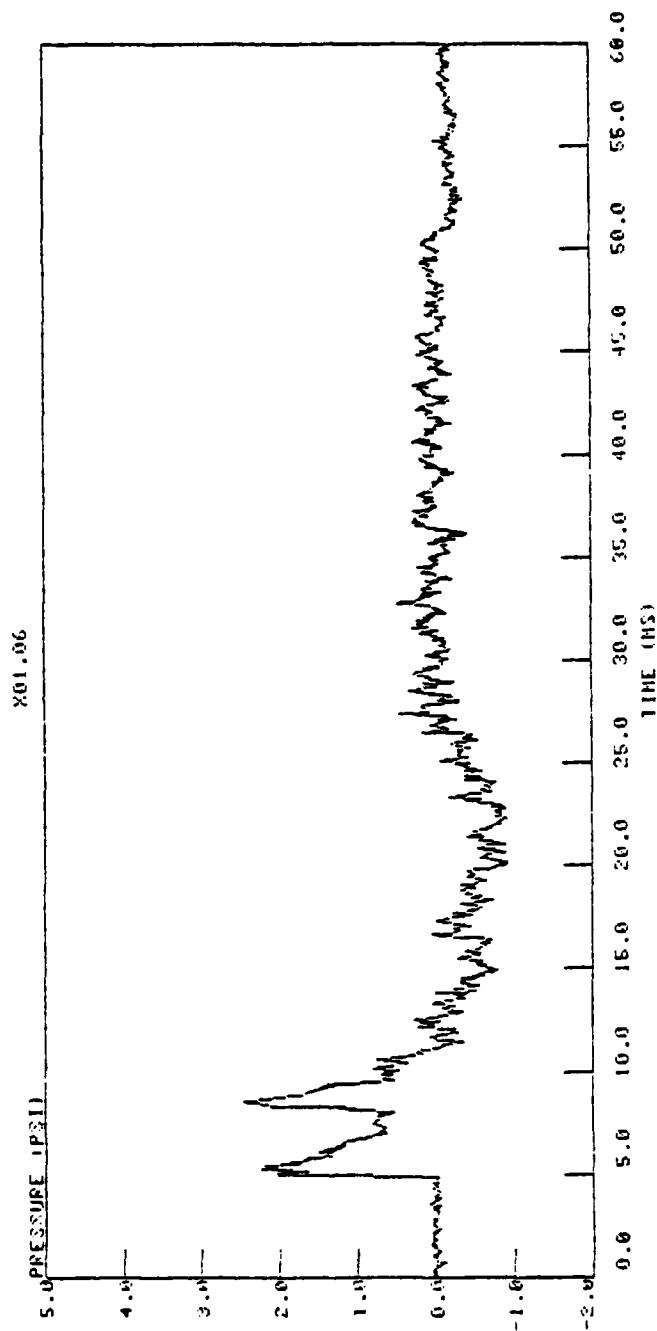
- 5-1 Shock Tube - May 79, Gauge 2, Day 8, On-Axis, Grazing, Shot 5
- 5-2 M198 - May 79, C22, 5ft, 267/0, Shot 31
- 5-3 M198 - May 79, C22, 5ft, 267/0, Shot 15
- 5-4 M198 - May 79, C22, 5ft, 267/0, Shot 5
- 5-5 M198 - May 79, C22, 5ft, 800/0, Shot 11
- 5-6 M198 - May 79, C22, 5ft, 800/0, Shot 10
- 5-7 M198 - May 79, C22, 5ft, 800/0, Shot 3
- 5-8 Shock Tube - March 79, Gauge 2, Day 5, On-Axis, Grazing, Shot 6
- 5-9 Shock Tube - March 79, Gauge 2, Day 5, On-Axis, Grazing, Shot 16
- 5-10 Shock Tube - March 79, Gauge 2, Day 5, On-Axis, Grazing, Shot 6
- 5-11 Shock Tube - May 79, Gauge 2, Day 8, On-Axis, Grazing, Shot 18
- 5-12 Shock Tube - May 79, Gauge 2, Day 7, On-Axis, Grazing, Shot 18
- 5-13 Shock Tube - May 79, Gauge 2, Day 7, On-Axis, Grazing, Shot 4
- 5-14 Shock Tube - May 79, Gauge 2, Day 6, On-Axis, Grazing, Shot 18
- 5-15 M198 - Nov 78, C22, 5ft, 800/0, Shot 31
- 5-16 M198 - Nov 78, C22, 5ft, 800/0, Shot 30
- 5-17 M198 - Nov 78, C22, 4ft, 267/0, Shot 17
- 5-18 M198 - Nov 78, C22, 4ft, 267/0, Shot 14
- 5-19 M198 - Nov 78, C22, 4ft, 267/0, Shot 15
- 5-20 M198 - Nov 78, C22, 5ft, 800/0, Shot 32



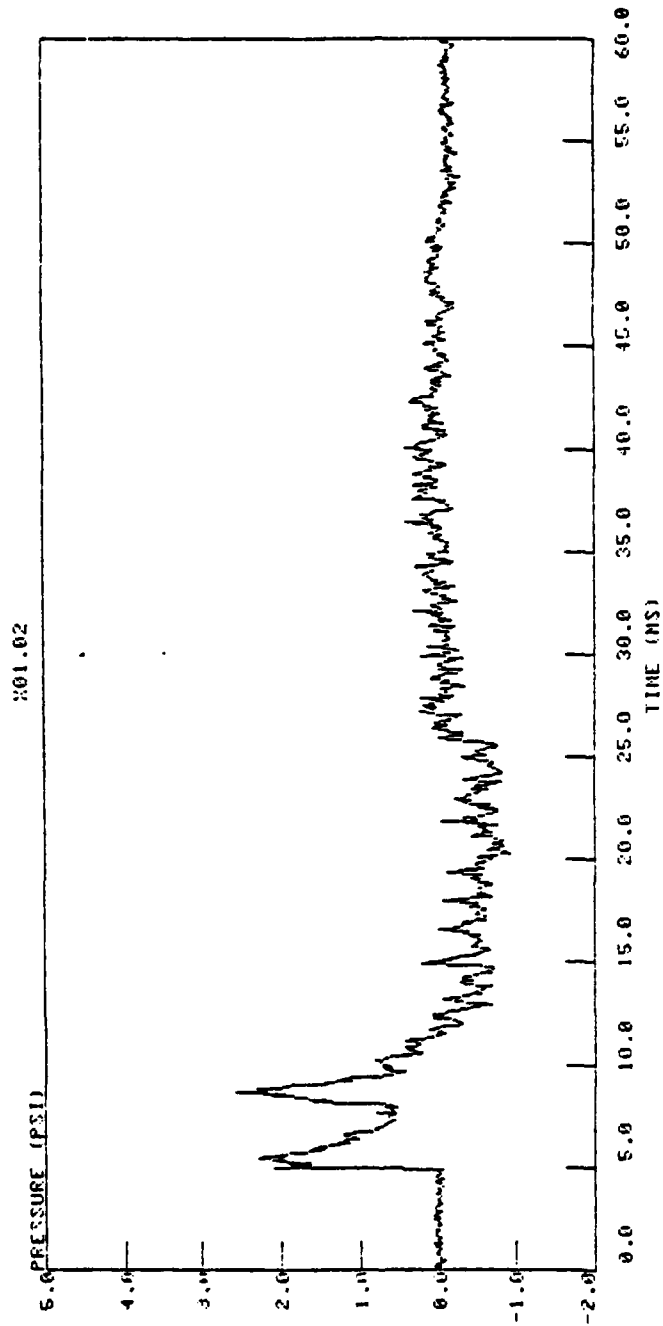
Graph 5-1. Shock Tube, May 79, Gauge 2, Day 8, On-Axis, Grazing, Shot 8



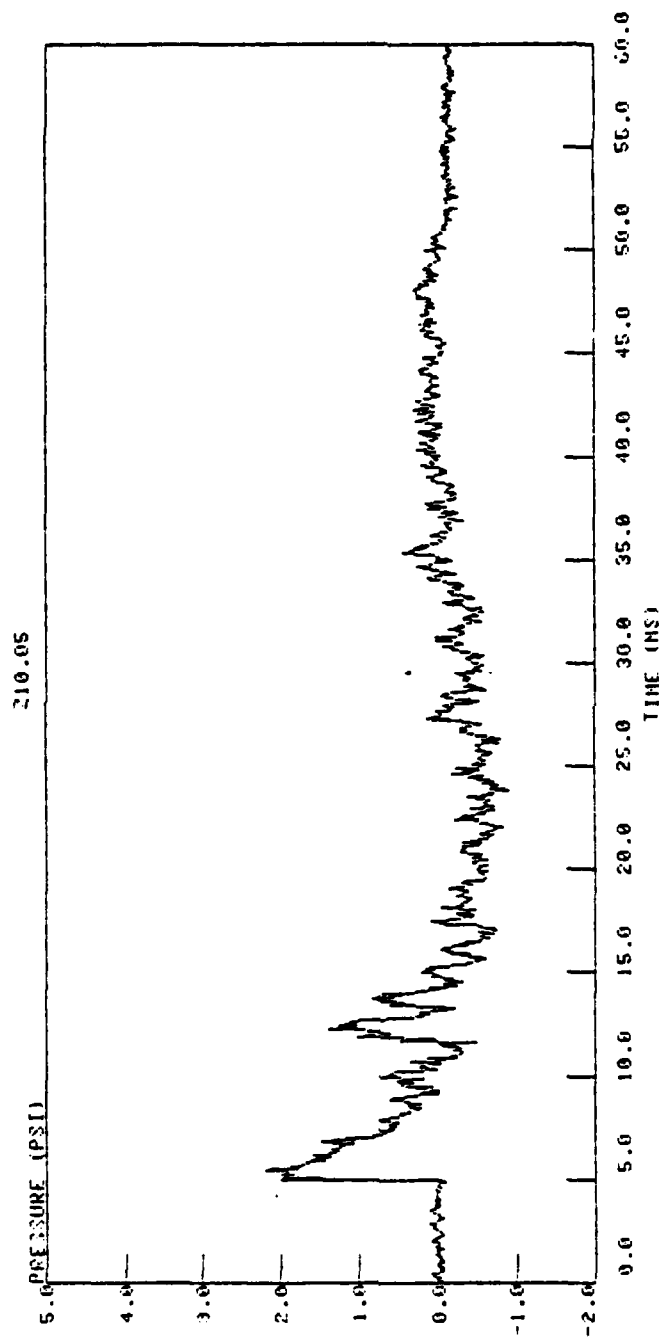
Graph 5-2. M198 - May 79, C22, 5 ft, 267/0, Shot 31



Graph 5-3. M198 - May 79, C22, 5 ft, 267/0, Shot 15

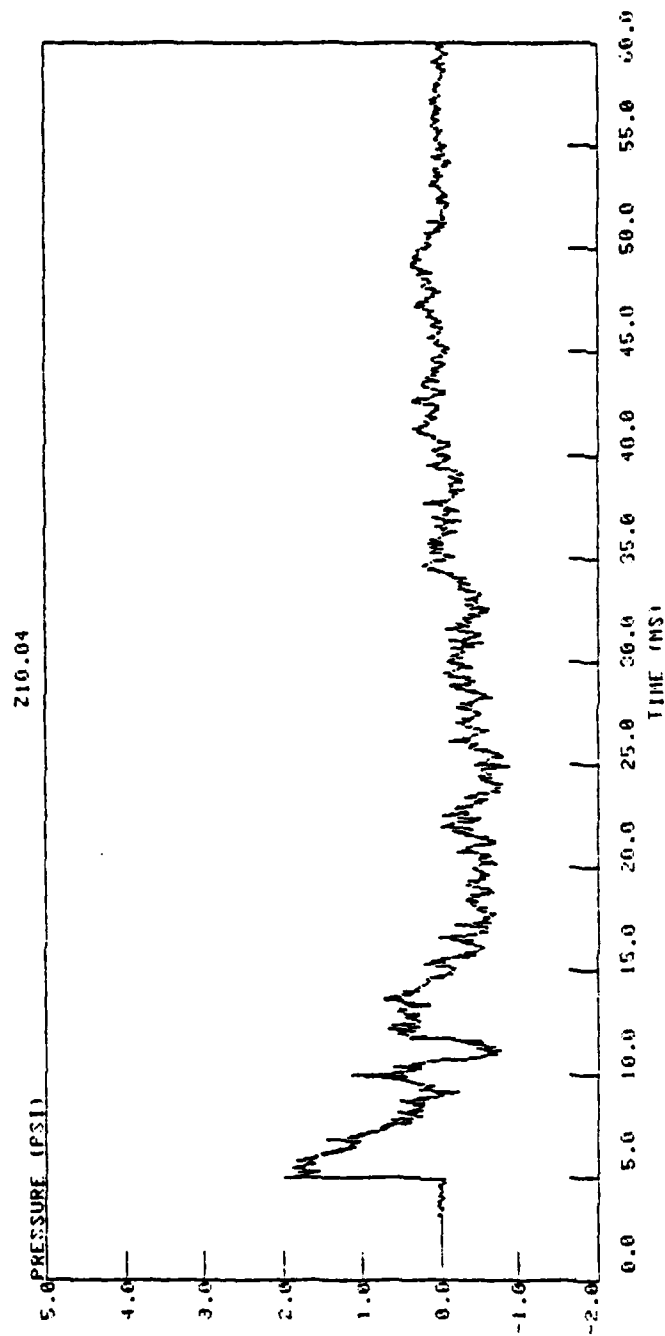


Graph 5-4. M198 - May 79, C22, 5 ft, 267/0, Shot 5

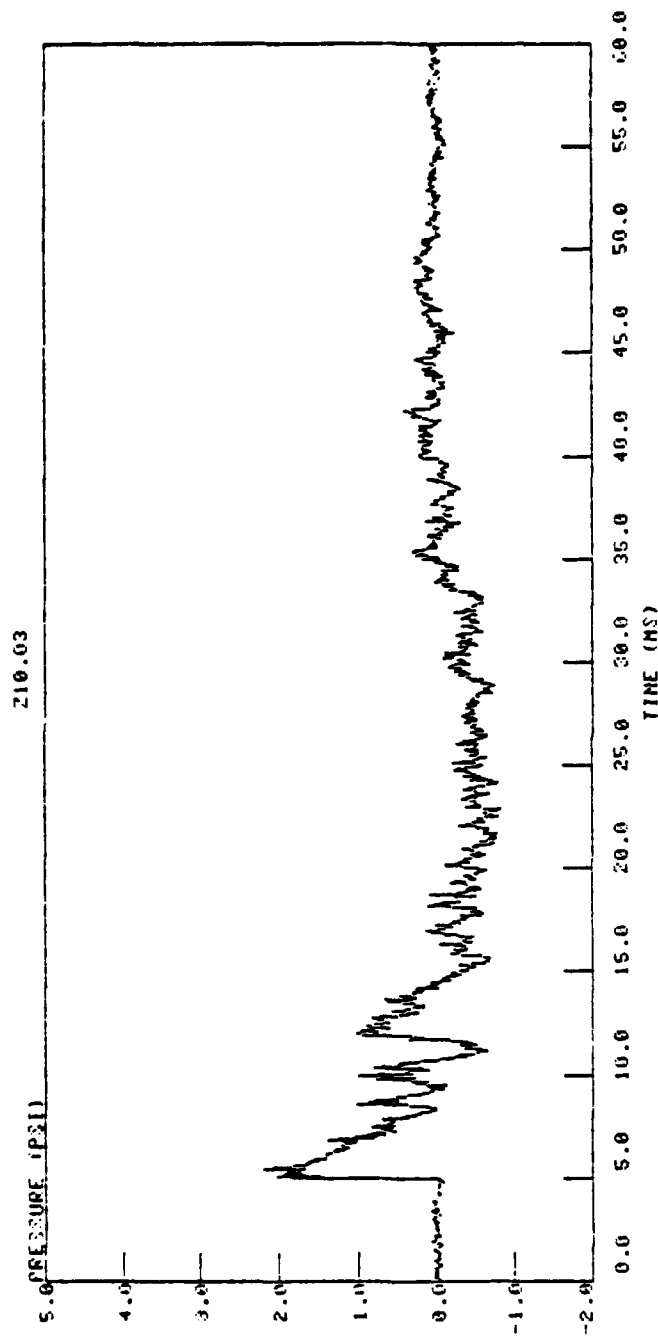


Graph 5-5. M198 - May 79, C22, 5 ft, 800/0, Shot 11

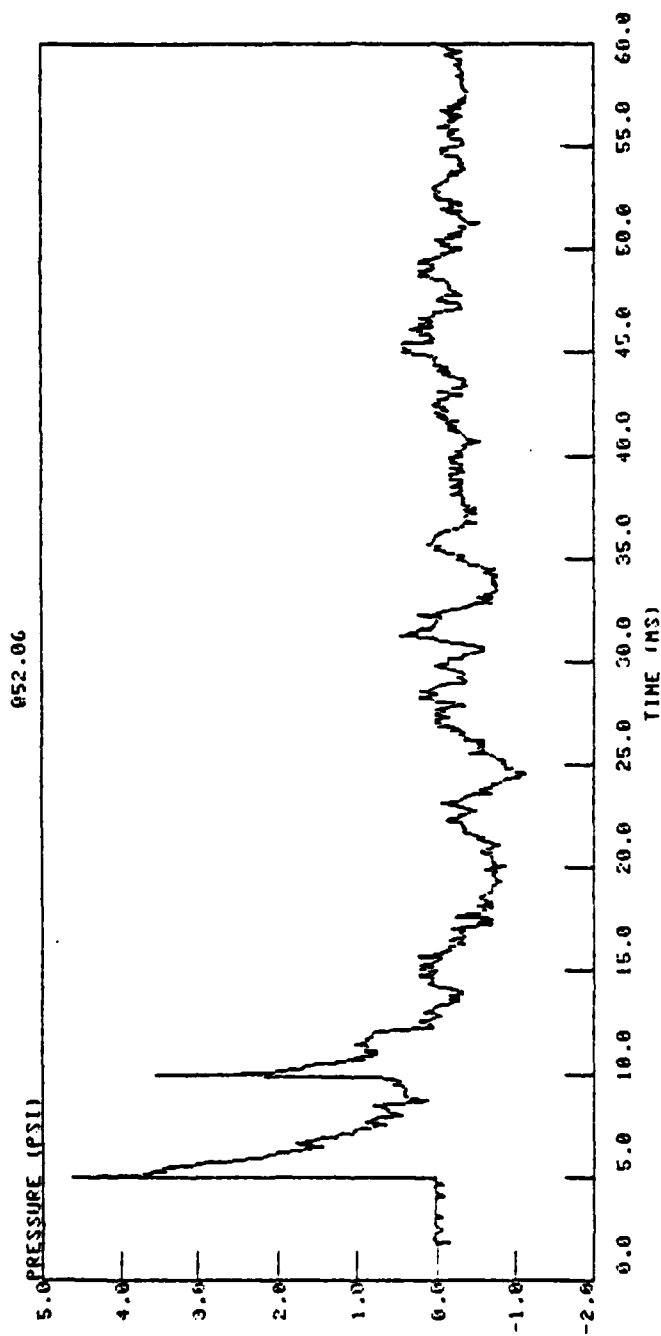




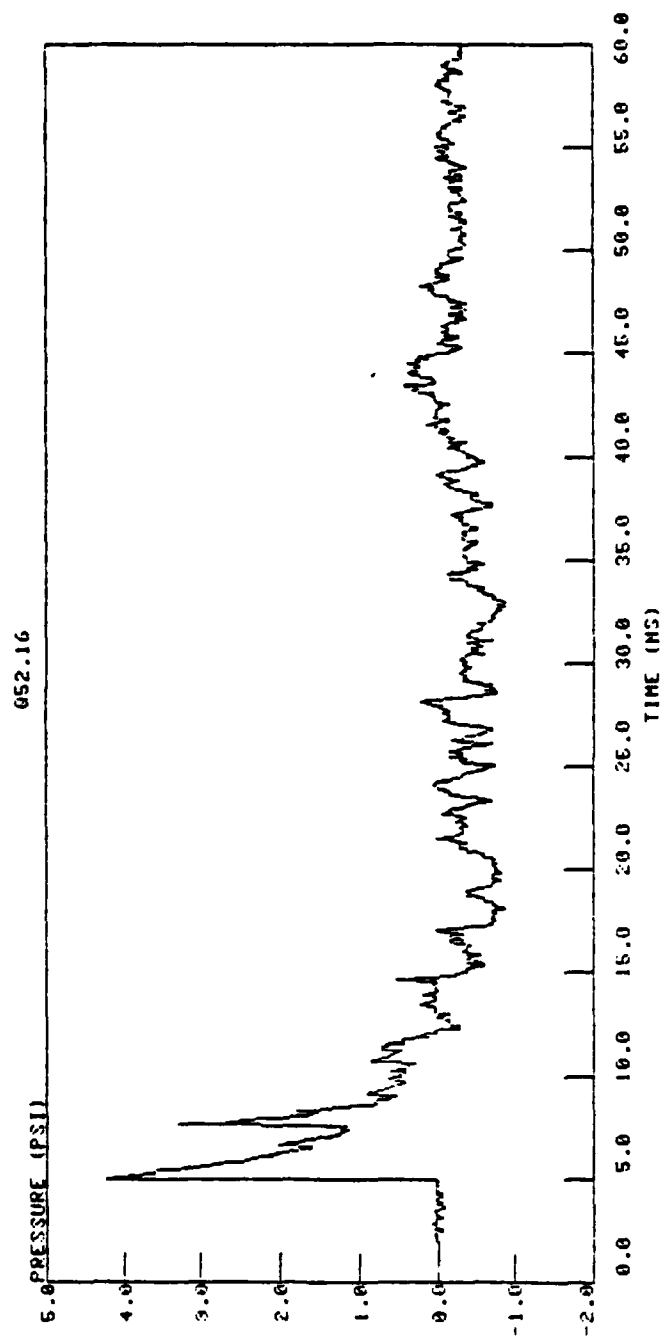
Graph 5-6. M198 - May 79, C22, 5 ft, 800/0, Shot 10



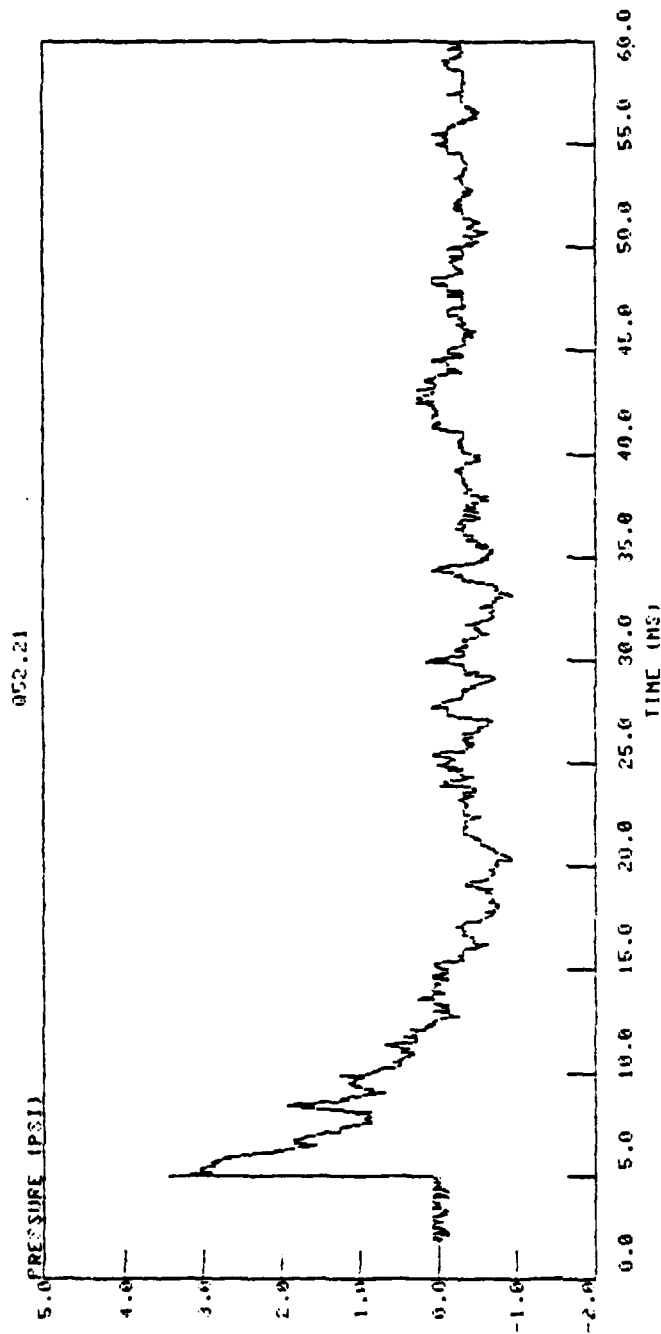
Graph 5-7. M198 - May 79, C22, 5 ft, 800/0, Shot 3



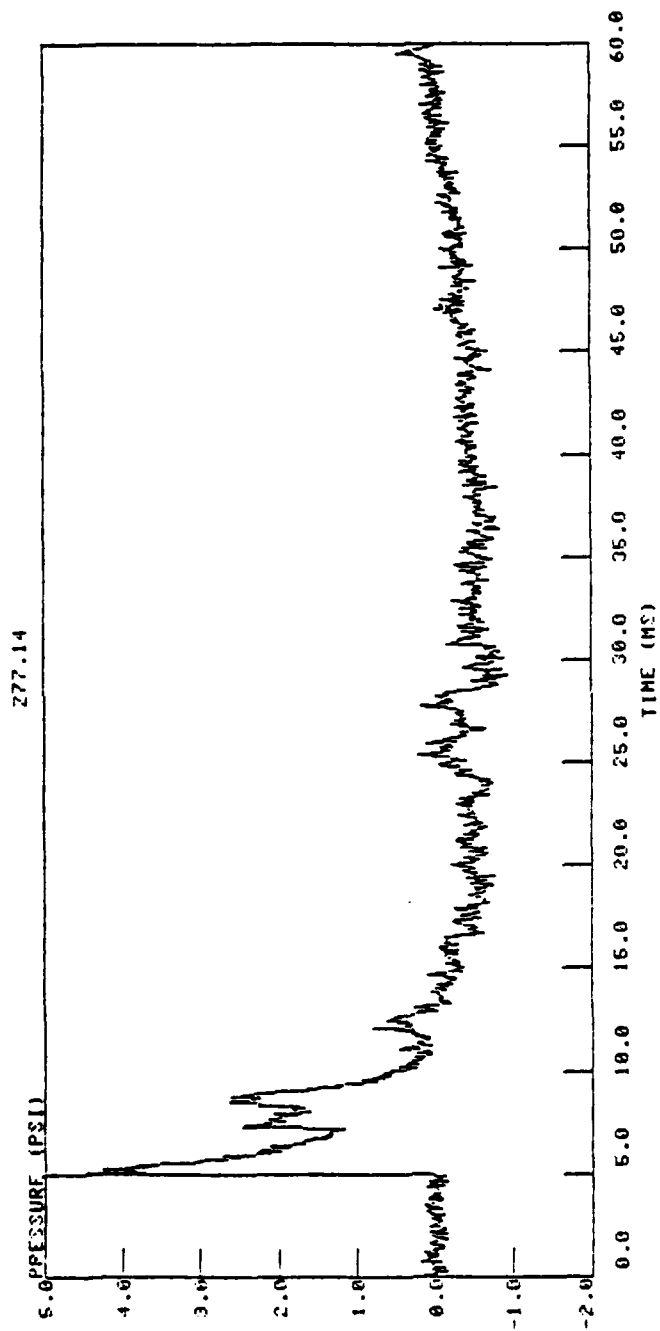
Graph 5-8. Shock Tube - March 79, Gauge 2, Day 5, On-Axis, Grazing, Shot 6



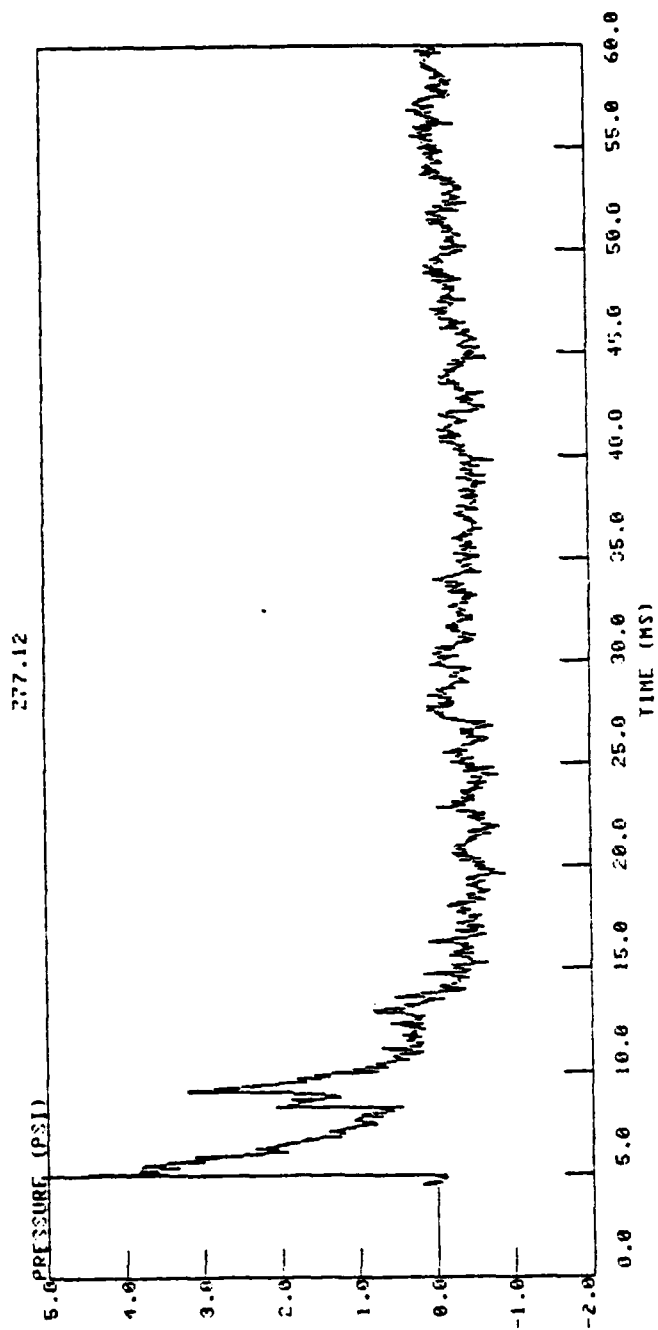
Graph 5-9. Shock Tube - March 79, Gauge 2, Day 5, On-Axis, Grazing, Shot 16



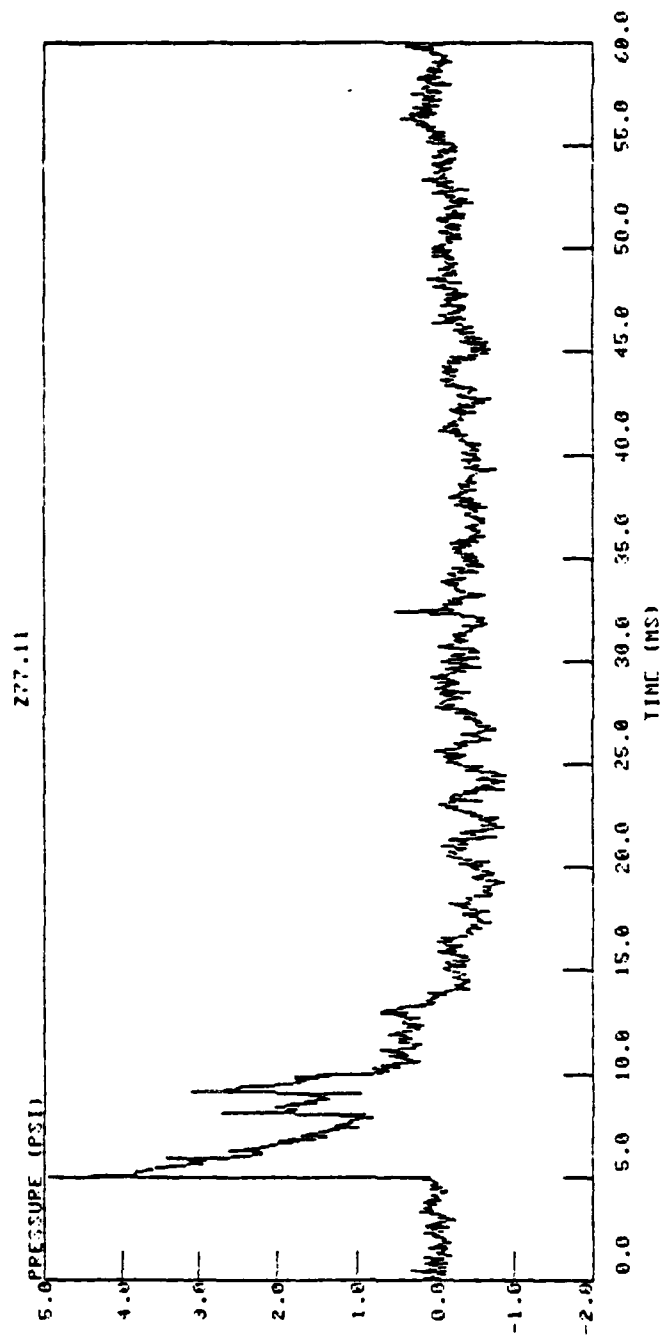
Graph 5-10. Shock Tube - March 79, Gauge 2, Day 5, On-Axis, Grazing, Shot 6



Graph 5-11. Shock Tube - May 79, Gauge 2, Day 8, On-Axis, Grazing, Shot 18

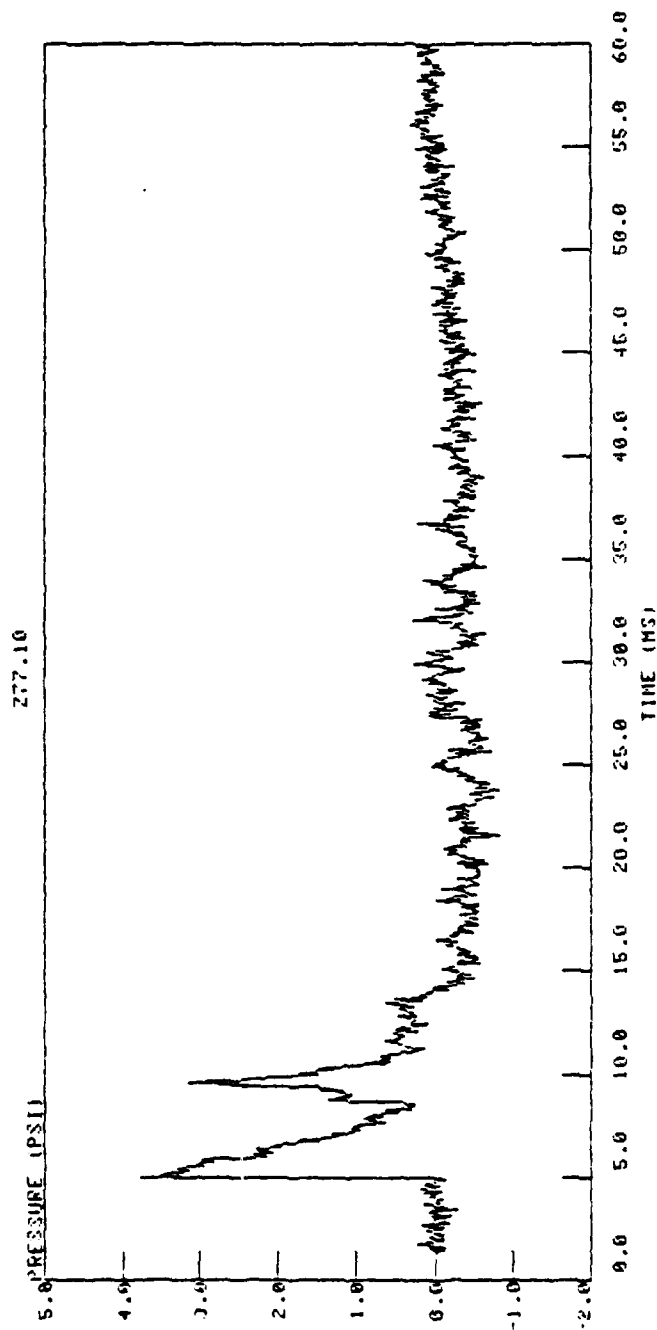


Graph 5-12. Shock Tube - May 79, Gauge 2, Day 7, On-Axis, Grazing, Shot 18



Graph 5-13. Shock Tube - May 79, Gauge 2, Day 7, On-Axis, Grazing, Shot 4





Graph 5-14. Shock Tube - May 79, Gauge 2, Day 6; On-Axis, Grazing, Shot 18

AD-A118 400

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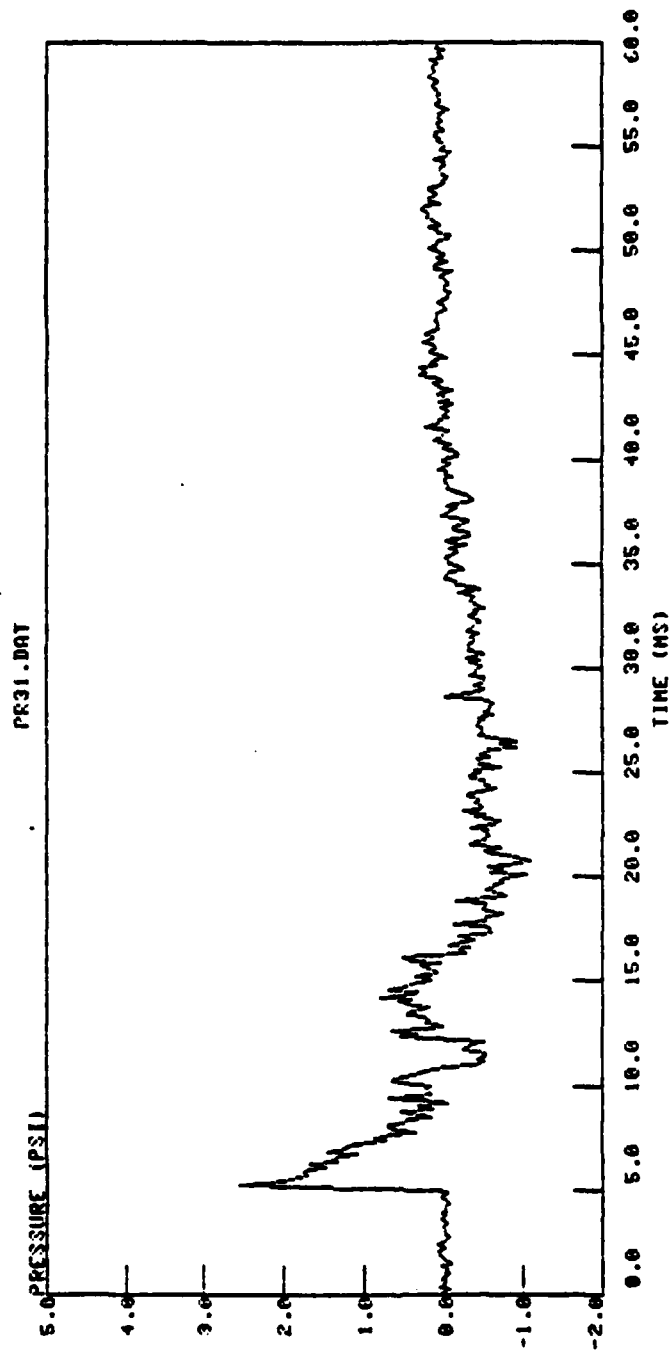
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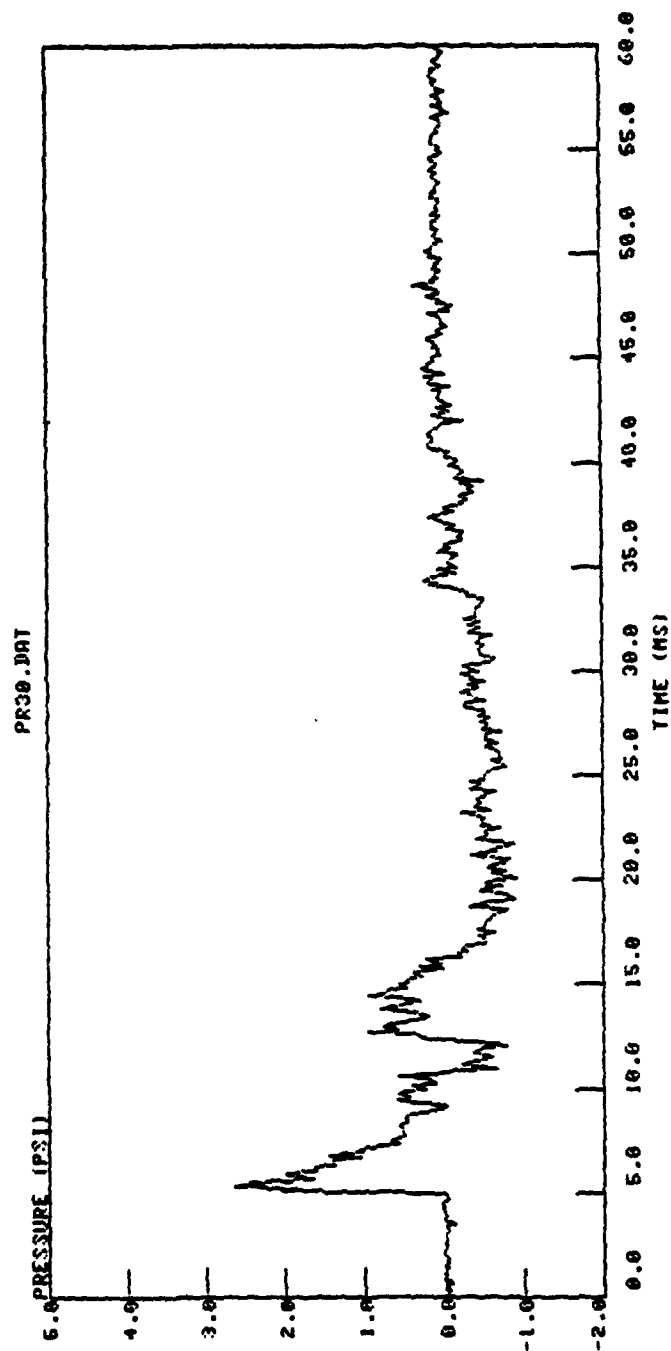
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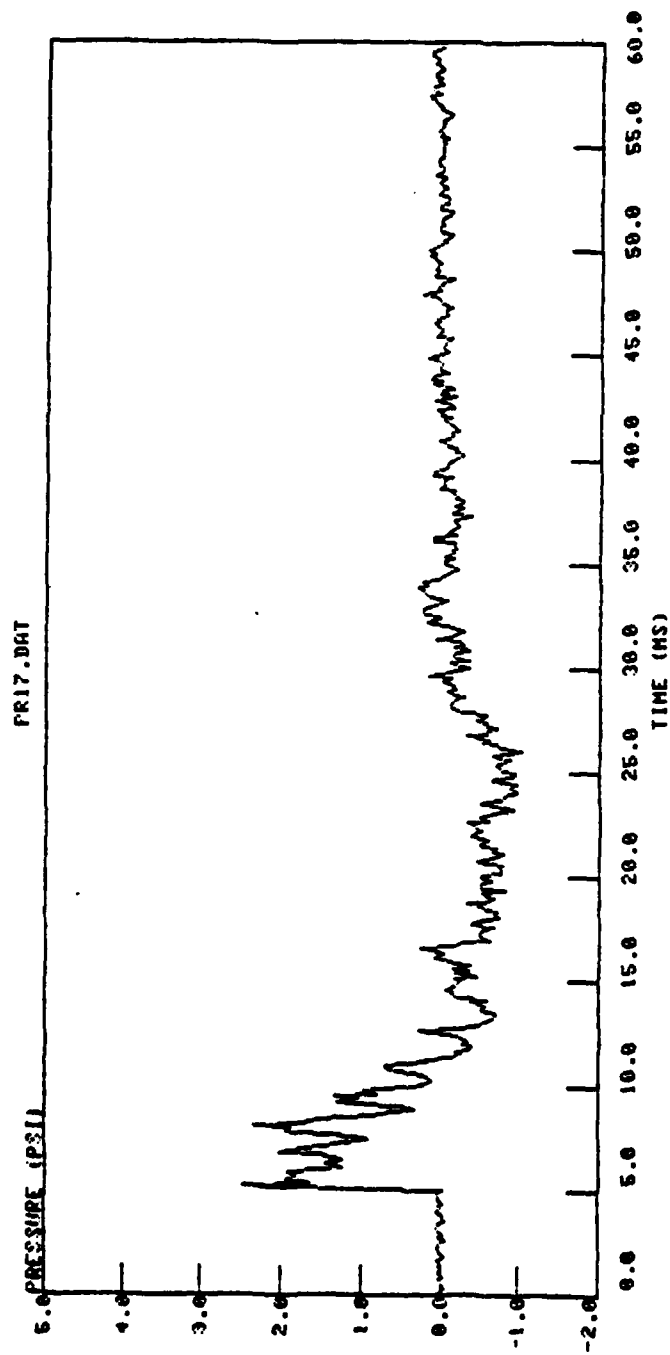
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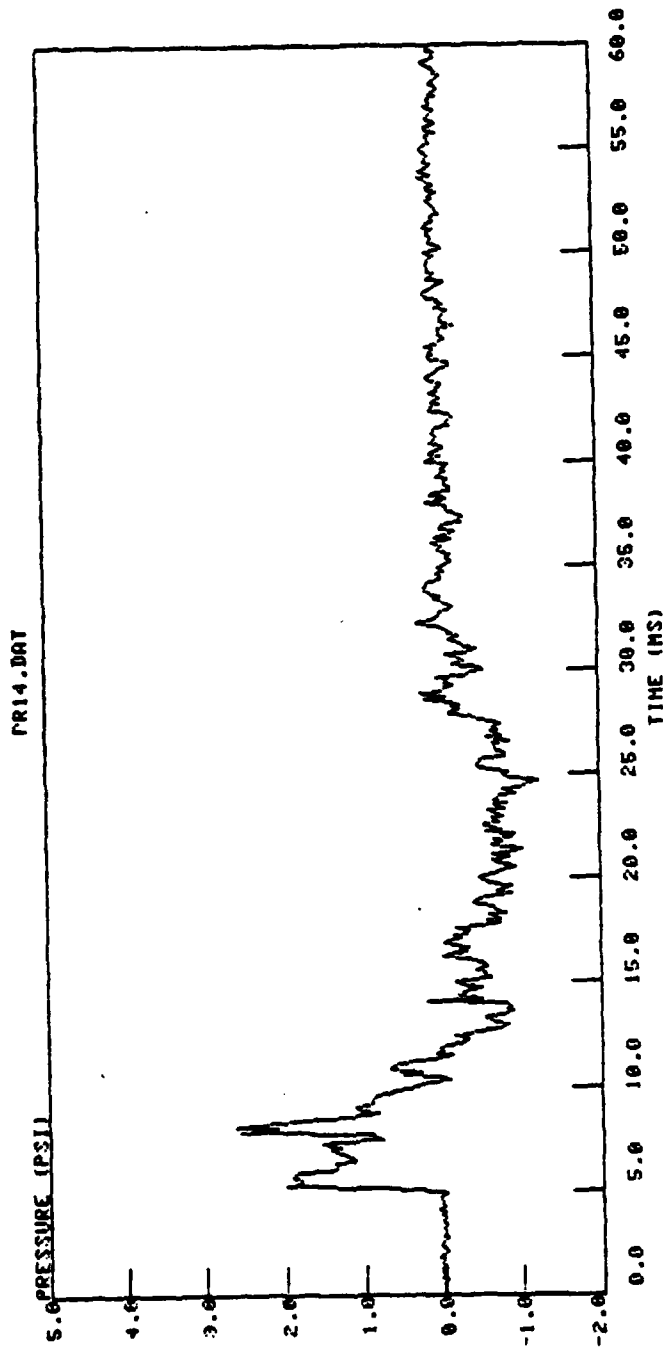
Graph 5-15. M198 - Nov 78, C22, 5 ft, 800/0, Shot 31



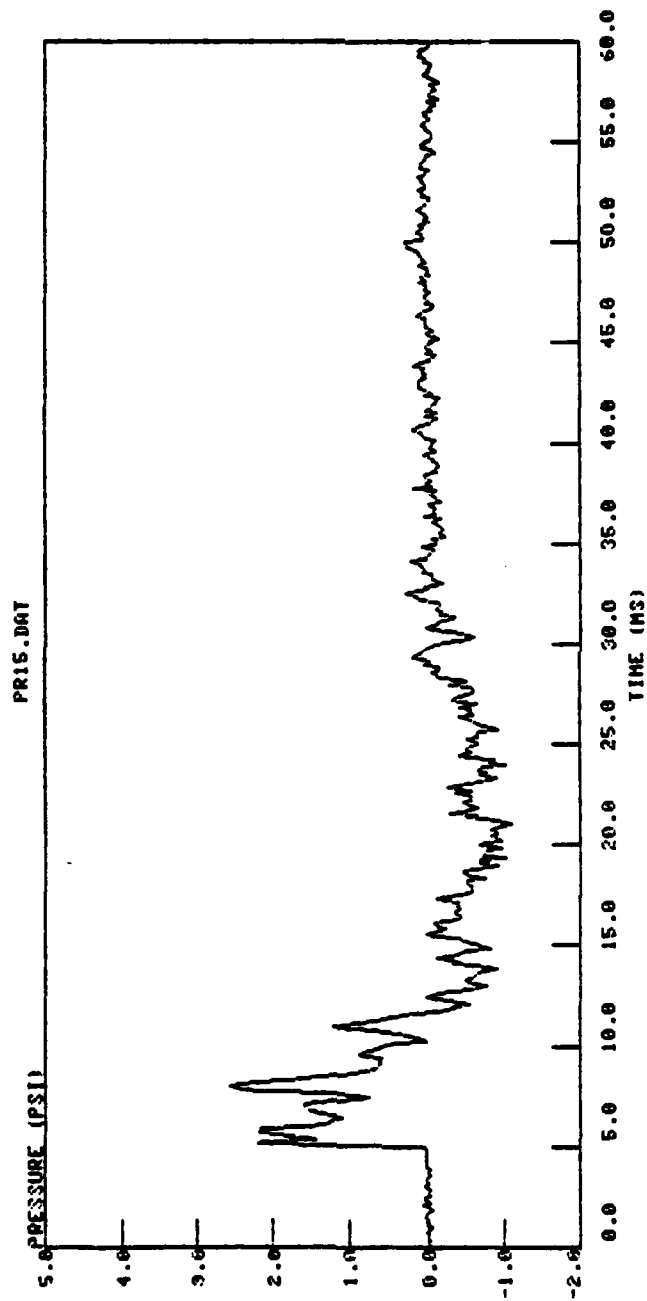
Graph 5-16. M198 - Nov 78, C22, 5 ft, 800/0, Shot 30



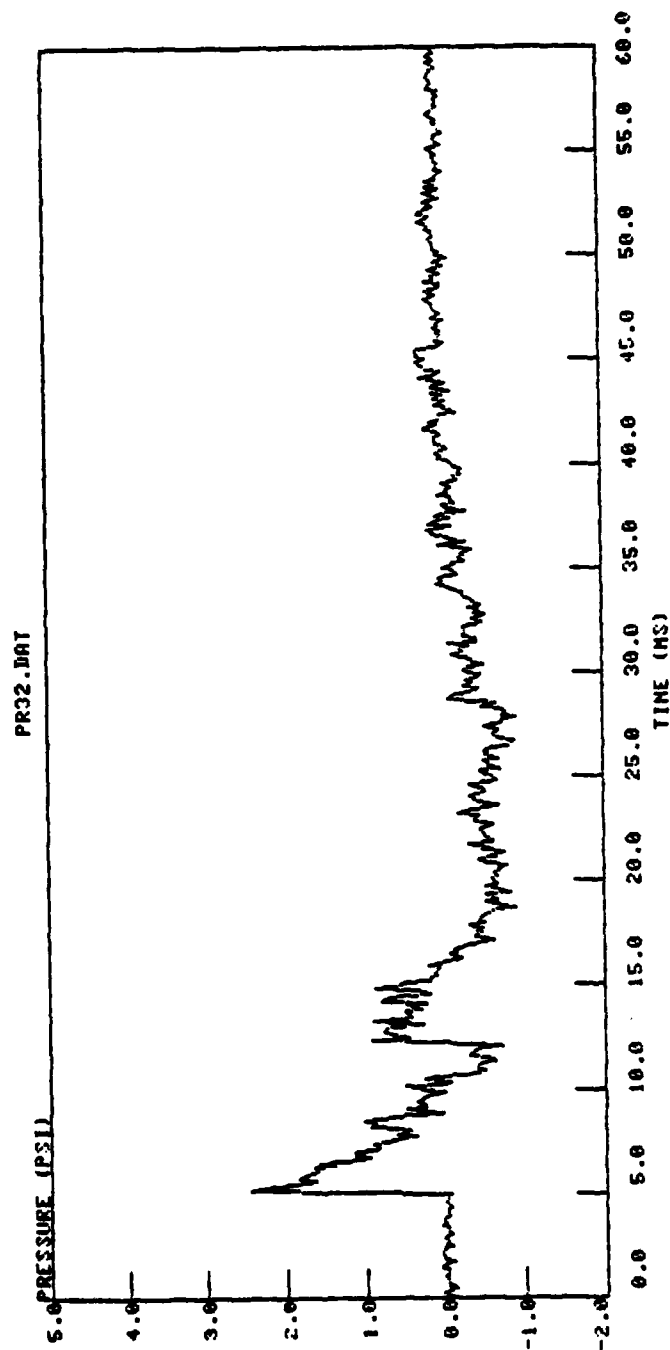
Graph 5-17. M198 - Nov 78, C22, 4 ft, 267/0, Shot 17



Graph 5-18. M198 - Nov 78, C22, 4 ft, 267/0, Shot 14



Graph 5-19. M198 - Nov 78, C22, 4 ft, 267/0, Shot 15



Graph 5-20. M198 - Nov 78, C22, 5 ft, 800/0, Shot 32



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